Compressed Air Magazine

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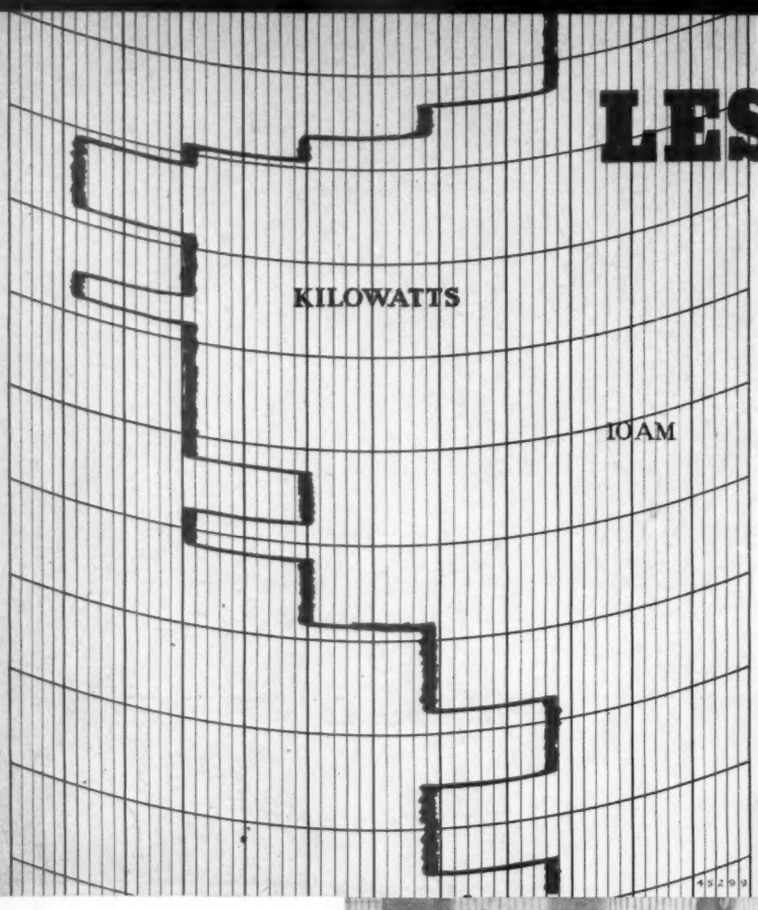
BUNKERING THE LINER "MAJESTIC" WITH FUEL OIL



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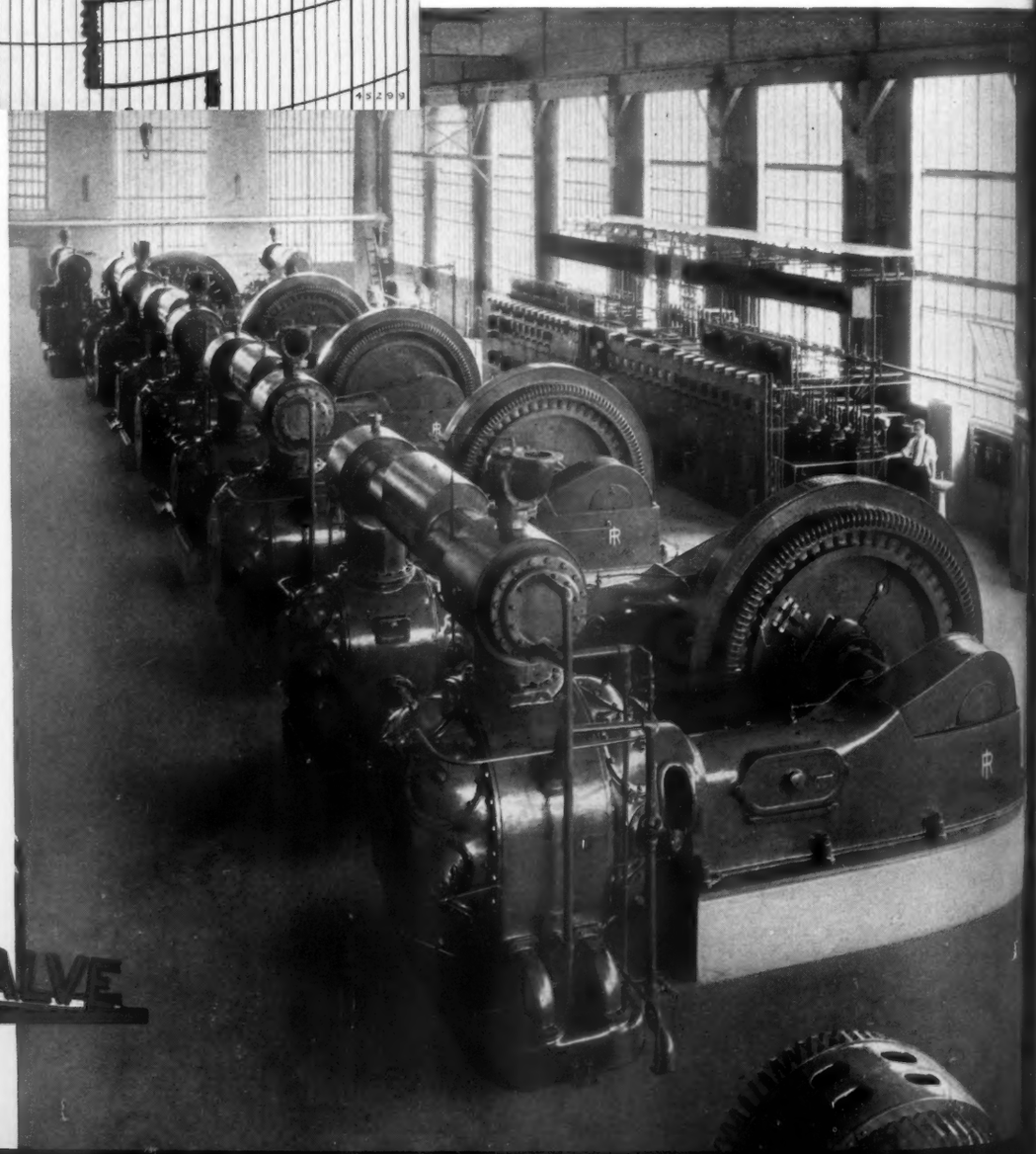

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3641

ON THE COVER

THE Pan American Petroleum & Transport Company's 15,000-ton tanker *Cerro Ebano* is shown pumping fuel oil aboard a Cunard-White Star liner in New York Harbor. The transfer is being made through a 10-inch reinforced rubber hose. The picture illustrates the ease, quickness, and cleanliness of bunkering ships that use oil for fuel.

•

THERE have been few years in the past hundred when New York City was not either constructing additional water-supply facilities or planning new ones to keep abreast of the ever-increasing demand. Work has now started on an 85-mile tunnel in solid rock that will tap the headwaters of the Delaware River, more than 100 miles from the City Hall on Manhattan Island. Our leading article describes the general features of this project, which will engage construction men for the next five to ten years.

•

SCIENTIFIC study has intervened to prevent the extinction of the oyster, one of our most beneficial seafoods. An account of the steps being taken to assure a continued supply of this popular bivalve is presented under the title, *The Oyster Opens Up.*

•

ENGINEERS of the Carter Coal Company in West Virginia had to sink a large shaft through known water-bearing ground. Past experience told them that they faced a long, expensive job if they followed conventional methods. By resorting to grouting of the area concerned they sealed off the water, and their troubles vanished. The story of this operation starts on page 5248.

•

THERE was a time when college professors were popularly believed to be long on theoretical knowledge and short on practical information. As everyone is aware, there was never much truth in that appraisal, and it is certainly far from being true now. For example, it was a college professor and not an oil-production man that called our attention to an error in the legend describing the picture that appeared on page 5200 of our December, 1936, issue. We are indebted to Prof. Eugene A. Stephenson of the Missouri School of Mines for pointing out that the stand of tubing shown in the background of the illustration was drill pipe and not casing, as it was designated.

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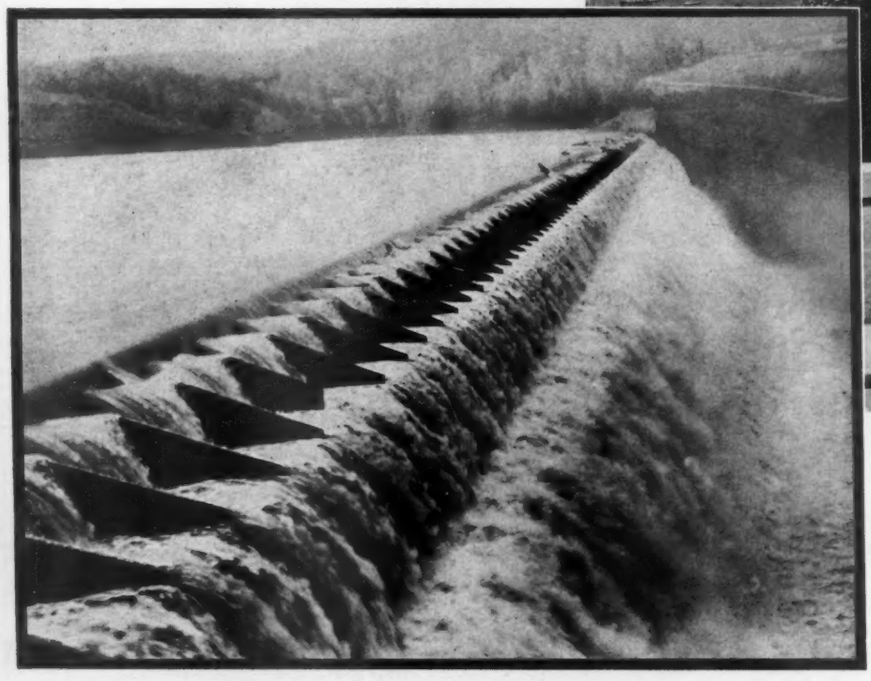
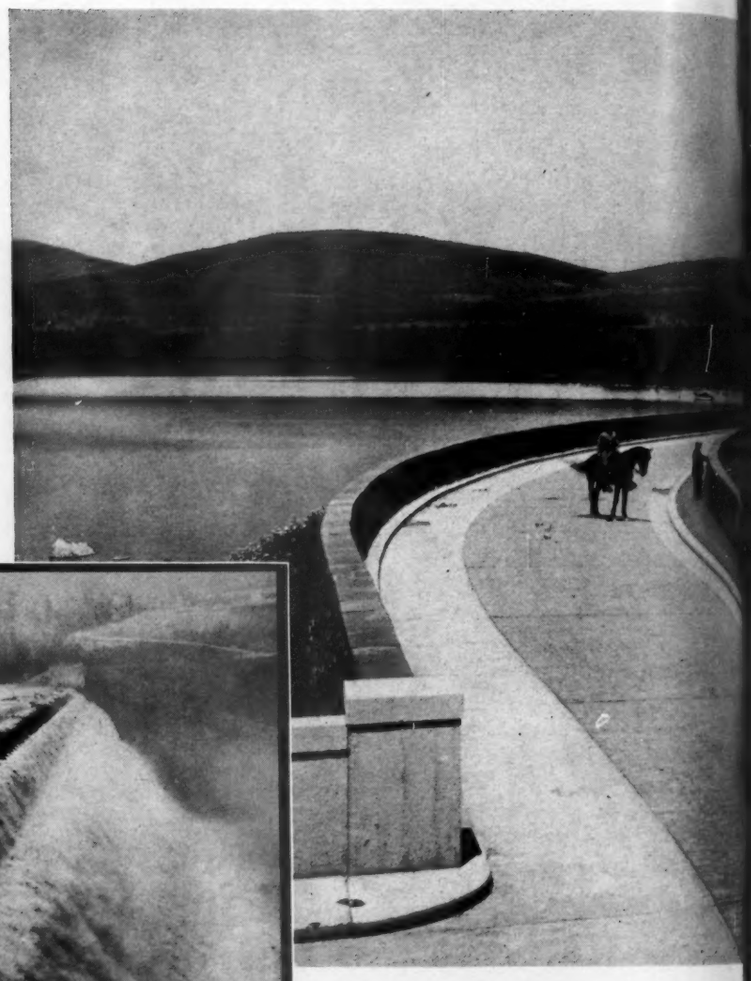




CATSKILL-SYSTEM STRUCTURE

Gilboa Dam (left) impounds the waters of Sch Creek, a tributary of the Mohawk River whic into the Hudson. The Schoharie watershed lies ward of the Esopus watershed from which it is rated by a divide. The dam consists of a spill tion of masonry, about 1,300 feet long and 18 maximum height, and of an earth section abo feet long. The masonry section is founded on roc is constructed of large blocks of stone buried i crete. The downstream face is in the form of a of steps with treads and rises ranging from 7 feet. It is shown with water flowing over it.

The main storage reservoir of the Catskill Supply System (center) is approximately 85 northwest of the city hall in New York in a line. It has a capacity of 128,000,000,000 gal water, enough to cover Manhattan Island to a of 30 feet. It was formed by damming Esopus

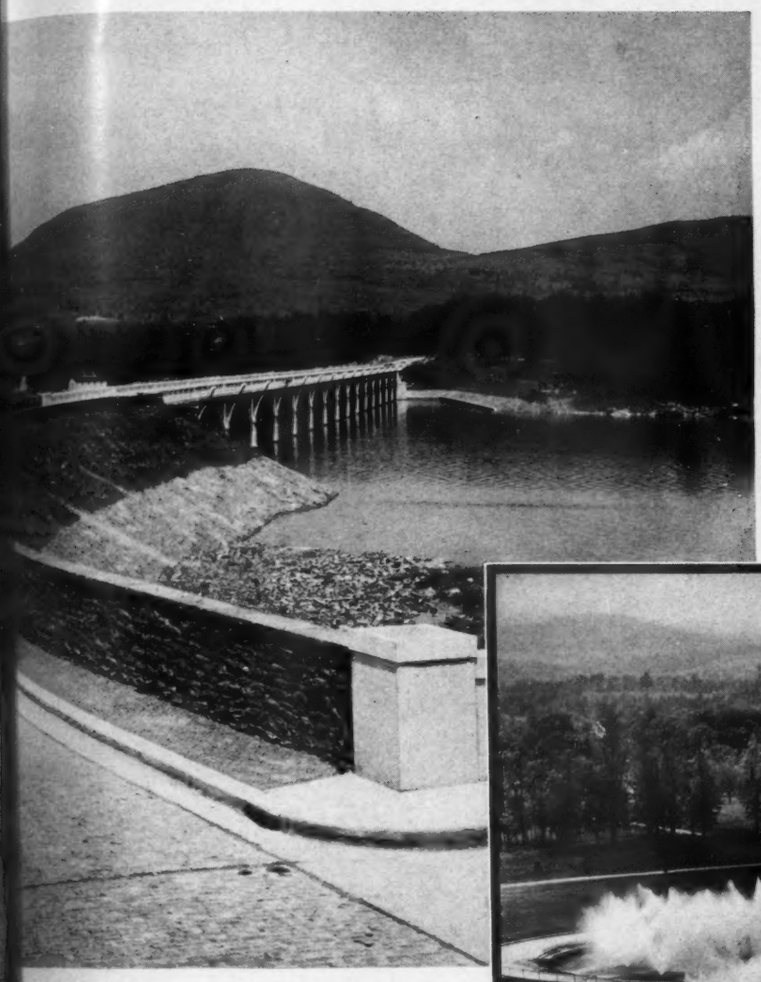
TO INCREASE its supply of mountain water, the City of New York is engaging upon one of the largest construction projects ever undertaken. There has been outlined a 3-stage program of which the first two will be carried out at once. The current work involves the building of three reservoirs and the boring of an 85-mile aqueduct, entirely in rock, to deliver the water to the city limits. This will be by far the longest tunnel in existence. The cost of the first two stages of the development is estimated at $272,587,000. This exceeds by more than $50,000,000 the cost of the Colorado River Aqueduct now being constructed to carry Colorado River water to Los Angeles and neighboring cities, and constitutes the largest sum ever to be spent at one time by a city in the development of its water-supply system.

The new part of the system is commonly called the Delaware River Project for the reason that the greater portion of the supply will come from the headwaters of the Delaware River. This watershed lies just over a divide that separates the drainage basin of the Delaware from that of the Hudson, the tributaries of which have been the principal sources of the water previously impounded for delivery to New York City. The work now being started would probably be well along towards completion had it not been for the intervention of the depression. Everything was in readiness to proceed in 1931, but economic conditions then were such as to make it difficult or impossible to finance so huge an undertaking. By way of adjustment, however, the slowing up of industrial activity served also to reduce the city's water consumption and to defer temporarily the need for increasing the available supply.

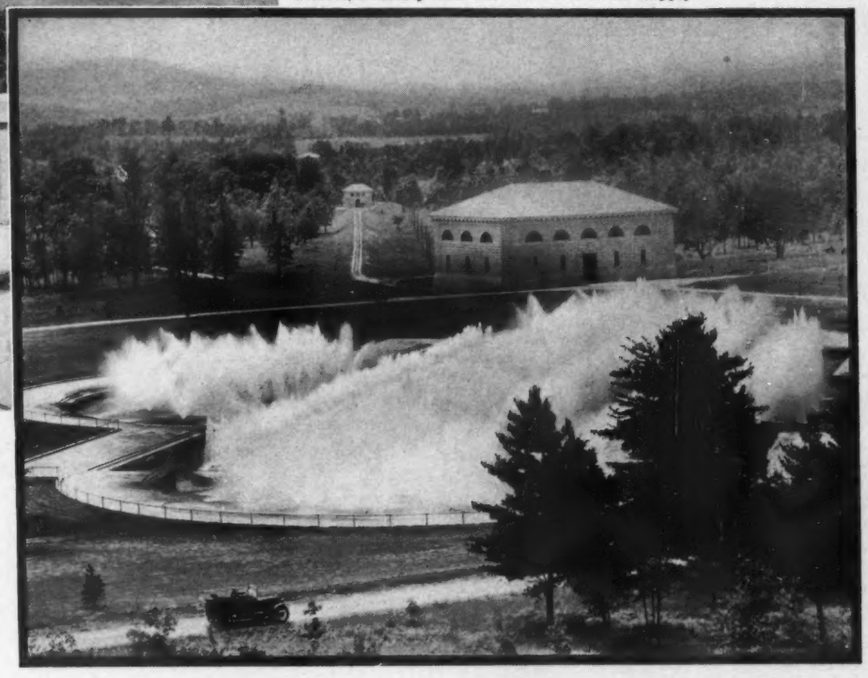
More Water f

The existing New York City water-supply system has cost approximately $585,000,000, and with the completion of the new facilities will have reached the stupendous total of $857,000,000. That sum would be sufficient to build ten standard concrete roads across the United States, or eight Boulder Dams each complete with its own power plant.

The figures do not connote extravagance,



Photos, Courtesy New York Board of Water Supply



building dikes to close the gaps between the rrounding the basin. The main structure, ridge Dam, is 4,650 feet long, 252 feet high, of masonry faced with concrete blocks. This shows the weir dike that divides the reservoir o pools, permitting water to be drawn from that the reservoir where the quality is best. Ashokan oir lies at an elevation, at full pool level, of 00 feet above sea level.

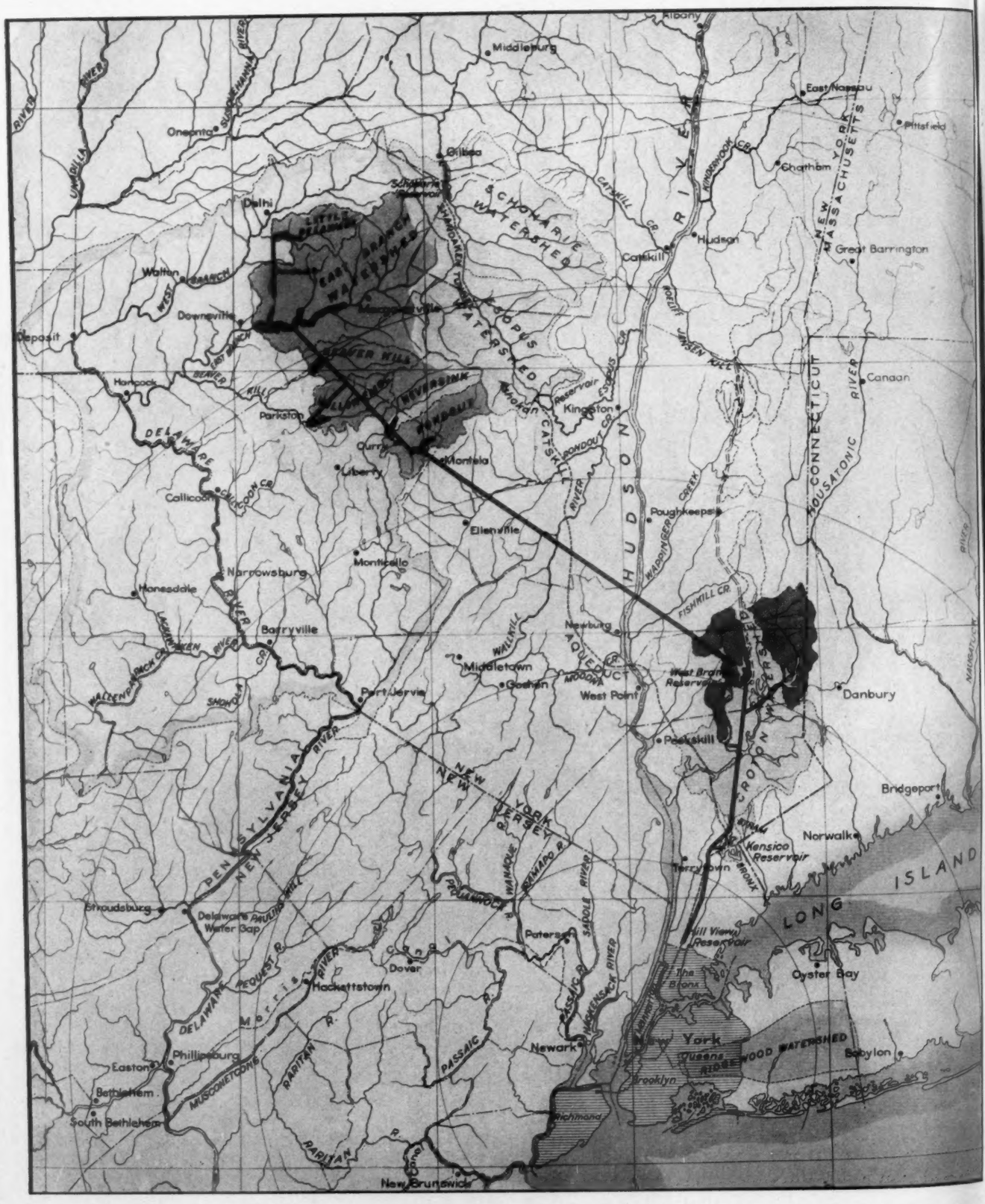
is aerator (right), located just below Ashokan ir, the water is sprayed vertically into the air nozzles. This mixes it thoroughly with oxy- moves objectionable gases, and breaks down otained matter that might affect the taste or an odor to the water. From the 500x200-foot basin the water flows through the screen r in the building on the far side, and then en- e aqueduct, the embankment of which can be tending through the cleared space. A similar basin is located just below Kensico Reservoir.

w York City

however. They are large merely because New York City is large. The average cost of water for each resident is slightly more than one cent a day, and until rates were increased, in 1934, it was only three-fourths of a cent a day. The quality of the water is high. Virtually the entire supply is derived from elevated mountain regions where natural purifying agencies are continually at work. To avoid contamination the city has acquired generous strips of land surrounding the principal reservoirs, and these areas have been cleared of all undesirable vegetation and planted with evergreens. Control is maintained over streams that feed the reservoirs, and under authority vested in it by the State Legislature the city negotiates with communities within the watershed to insure the provision of adequate sewerage systems. In one instance these negotiations resulted in the building of sewage disposal plants for two villages at a cost of $700,000.

In addition to these safeguards the water is aerated, treated with alum for the removal of turbidity, and chlorinated to eliminate harmful bacteria. Only sufficient chlorine is introduced, however, to effect sterilization. It is not perceptible to the taste, and New York water is known for its palatability. Besides, it is relatively soft, and its temperature is such that the product of household taps needs cooling during only protracted stretches of hot weather. All in all, one of New York's primary assets is its water. It should be recorded to the credit of those that have been concerned with this utility throughout the years of the city's major growth that all proposals to take water from more accessible but less desirable sources have been rejected, and that there has been no hesitancy in spending huge sums to go farther and farther afield as additional supplies have been required.

Although the margin between consumption and available water has at times become rather narrow, New York users have been unusually free from restrictions in recent years, and the impression of the casual visitor is that there is an unlimited supply. Despite the absence of stinting, it is a sin-



SOURCES OF NEW YORK'S WATER

The heavy line shows the route of the Delaware Aqueduct, on which construction will start at once. For the present, only the Neversink and Roundout watersheds will be developed. As that work proceeds, plans will be made for a reservoir on the East Branch of the Delaware and for a tunnel to connect it with the Neversink Reservoir. These facilities will, upon completion, add 540,000,000 gallons daily to the city's water supply and bring the available total to 1,579,000,000 gallons. At some future date reservoirs will be built on the Little Delaware River, Beaver Kill, and Willowemoc Creek, together with the necessary tunnels to link them with the remainder of the system. These works would further increase the daily supply by 160,000,000 gallons. Aerial surveying was used extensively and to advantage in laying out the line for the new aqueduct. The distance between each of the part-circles is 25 miles.

KENSICO DAM

This structure, across the valley of the Bronx River in Westchester County and some 30 miles north of New York's city hall, contains nearly 1,000,000 cubic yards of masonry. Its main section is 1,825 feet long and rises 307 feet above the rock foundation on which it rests. It is faced with concrete blocks on the upstream side and with granite on the downstream side. Contraction joints, spaced 80 feet apart, take care of movements caused by seasonal changes in temperature. Its reservoir covers an area of 2,218 acres and has a capacity of 29,000,000,000 gallons, or approximately a month's supply for the city. The water surface is at an elevation of 355 feet above sea level.

gular fact that the per capita consumption of water is less than in many other big cities of the country. It is notably smaller than that of some of the municipalities in the Great Lakes region. The average household in New York pays a flat rate for its water and is not metered, although users who prefer it may have meters installed. Industrial plants, hotels, and other consumers of large quantities are metered.

The growth of the city's water-supply system has been attended by an abundance of engineering romance, and the work that is now starting will add another interesting chapter to a story that is probably still far from finished. A brief review of the history of the system will provide a better perspective of the Delaware River Project.

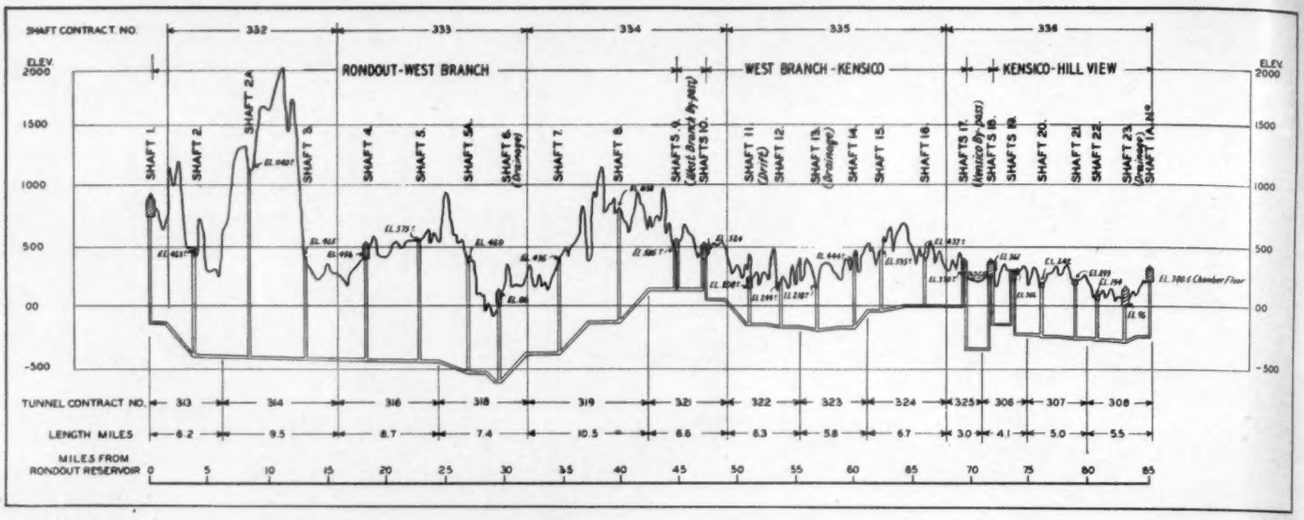
When the Dutch settled upon the tip of Manhattan Island they found numerous small brooks and a large fresh-water pond, known as the Collect, that was fed by springs. The first supply of water was obtained principally from private wells that tapped a layer of sand a few feet below the surface. In 1658 a public well was dug near Bowling Green, and subsequently more wells were opened at various street corners. But as the population grew some of these sources became contaminated, and people that could afford it began to haul water from wells farther northward. The first water shortage of consequence came about 1774, by which time New York had 20,000 inhabitants. Christopher Colles, an English engineer, then proposed to pump water from the Collect and from wells into a reservoir at Broadway and White streets, using hollowed logs for pipes and an old Newcomen steam engine for power. Work was begun on this project, but the Revolution abruptly stopped it.

By 1800 the population was 60,000, the shortage of water was acute, and an epidemic of yellow fever emphasized the imperative need for action. In the solution of the problem confronting the city, water, politics, and banking became peculiarly intermingled. Alexander Hamilton was at the time the leader of the Federalist party, which controlled the State Legislature, and was a director of the Bank of New York. Aaron Burr headed the rival Republican party, which later became the Democratic party. He and his associates were anxious to start a bank, but a franchise was denied them. In 1799 they organized the Manhattan Company, ostensibly to supply the city with water from the Bronx River. In their charter, however, they inserted a joker clause that empowered them to use surplus funds to engage in banking. Forthwith, they opened the Bank of the Manhattan Company in Wall street. It is now the oldest financial institution in the city.

Instead of bringing water from the Bronx River, the company built a stone reservoir on Chambers Street and, subsequently, an iron tank near the Collect. Into these they pumped water with two 18-hp. steam engines, and distributed it by gravity through 20 miles of bored-log pipes, some of which are still occasionally unearthed by excavators. The tank was torn down only about twenty years ago. The Manhattan Company served about 1,400 houses, the total daily supply being about 700,000 gallons.

The first municipal water works was constructed about 1830, and consisted of an elevated tank at Broadway and 13th Street from which radiated some 7 miles of cast-iron distribution pipes. The 230,000-gallon tank was supplied with water by a shaft 16 feet in diameter, 112 feet deep, and having two galleries, each 75 feet long, extending horizontally from a level near its bottom. A 12-hp. engine drove the pump.

For many years it had been evident that the city would have to go beyond the boundaries of Manhattan Island for an adequate water supply, but the people clung tenaciously to their wells. Both the Bronx and the Croton rivers were considered potential sources. In a report made in 1832, Col. DeWitt Clinton favored the Croton, estimating that it would provide 20,000,000 gallons a day. He stated that, because of the inadequate and impure water close at hand, the people were paying $270,000 annually for hauling water in hogsheads from distant springs. Ships that called at the port would not use Manhattan water. Some



PROFILE OF NEW AQUEDUCT

The depth of the tunnel will vary with the depth of the rock surface, the aim being to provide at least 150 feet of rock cover throughout its length. For shaft-sinking purposes, the 85-mile line has been divided into six sections, and for the construction of the tunnel, itself, into thirteen sections. The deepest shaft, No. 2-A, will be carried down 1,546 feet.

of them brought enough with them for the round trip. Others secured water from Long Island or New Jersey, the yearly cost for this service being placed at $50,000.

There was much opposition to the Croton scheme. One company proposed as an alternative to drill deep wells into the rock beneath the island. It advanced the argument that water thus obtained would be "rock" pure, and would "remove the popular pretext of using alcohol to correct the impurities of the water now in general use," and thus promote the "great and noble cause of temperance in this city."

In 1834 the State Legislature passed an act to provide the City of New York with "pure and wholesome water," which wording has been retained in all water legislation subsequently passed. Maj. D. B. Douglass of the United States Military Academy was employed to make surveys and investigations. He favored the Croton River over the Bronx, stating that the latter would supply only about 6,000,000 gallons a day.

The first Croton Dam was built from 1837 to 1842 at a point about 36 miles north of the City Hall, the Croton being a tributary of the Hudson and entering it from the east. Croton Dam was a masonry structure, 50 feet high, erected partly on bedrock and partly on rock-filled log cribs placed in the stream. A smaller crib dam, 300 feet downstream, formed a pool that lessened the erosive action of the water flowing over the spillway of the main dam.

Water was delivered to the city through a horseshoe-shaped aqueduct constructed of rubble masonry with a brick lining and an arch and having a cross-sectional area of 53 square feet. This aqueduct crossed the Harlem River at the northern limit of Manhattan Island by way of High Bridge, a magnificent masonry structure of fifteen arches and modeled after the old Roman aqueduct bridges. It was 1,450 feet long between the gate houses at the ends and cost $1,000,000. To improve navigation on the Harlem River, the bridge was subsequently rebuilt, a steel arch supplanting three of the central arches.

After crossing the Harlem, the aqueduct continued onward to a receiving reservoir in Central Park. As it was then thought improbable that the northern part of the island would be settled, the aqueduct was run above ground, leaving a few archways for certain streets to pass through. But the city had so far encroached upon the section by 1865 that it was necessary to remove the aqueduct and to replace it with two 6-foot cast-iron pipes which were laid underground. In addition to the receiving reservoir there was a distributing reservoir on Murray Hill. Its site is now occupied by the Public Library at Fifth Avenue and 42nd Street.

Clinton had estimated the per capita consumption of water at 20 gallons daily. But it soon surpassed that figure, and, with the city growing rapidly, it was not long before another shortage was imminent. Drought conditions reduced the supply some years, and it was only by drawing upon lakes in the watershed that sufficient water was secured. To serve the section of New York above the Harlem River, then recently annexed, Kensico Dam was constructed in 1884 to impound the run-off of the Bronx and Byram rivers. Between 1873 and 1893 four storage reservoirs were also built in the Croton watershed.

Meanwhile plans had been launched for a new Croton Dam and aqueduct. The population had reached 1,200,000 by 1880, and the water supply amounted to 86,000,000 gallons daily from the Croton system, to which 16,000,000 gallons was added in 1884 from the Bronx and Byram system. According to estimates the total fell short of the requirements by 45,000,000 gallons.

The new Croton works were authorized in 1883 and were constructed between 1885 and 1907. A larger dam was built a few miles downstream from the old one. The aqueduct, save for about a mile, was in the form of a tunnel, its length being 33 miles. Access to the tunnel grade line was obtained through shafts spaced from 4,000 to 7,500 feet apart and varying in depth from 21 to 391 feet. Test borings were made with diamond drills, which was an innovation in engineering practice at that time. The exploration was inadequate, however, and in some places the tunnel ran into soft ground. The aqueduct had a cross-sectional area of 160 square feet, or more than three times that of the old one. Drilling at the tunnel headings was done with piston drills, the top-heading-and-bench method of advance being employed. Gasoline torches were used at first for illumination, but in 1886 incandescent lamps were introduced.

When the aqueduct started delivering water in 1890, the city had a population of 1,515,301. The new line had a carrying capacity of 300,000,000 gallons daily, and consumption, which had been greatly restricted, immediately mounted from 102,000,000 to 145,000,000 gallons a day, reaching 183,000,000 gallons in 1894. Demand fast crept up on the available supply. In 1898 the boroughs of Queens, Brooklyn, and Richmond were added to the city, and Greater New York was born. These localities had been providing their own water supply chiefly from wells and streams, but it now became advisable to consolidate the systems of supply wherever it was possible to do so.

But there seemed to be little disposition on the part of the city officials to act. Accordingly, a group of individuals sought to take advantage of the opportunity for profit that thus presented itself. The Ramapo Water Company was organized and, with the aid of friends in the State Legislature, was granted broad powers to acquire reser-

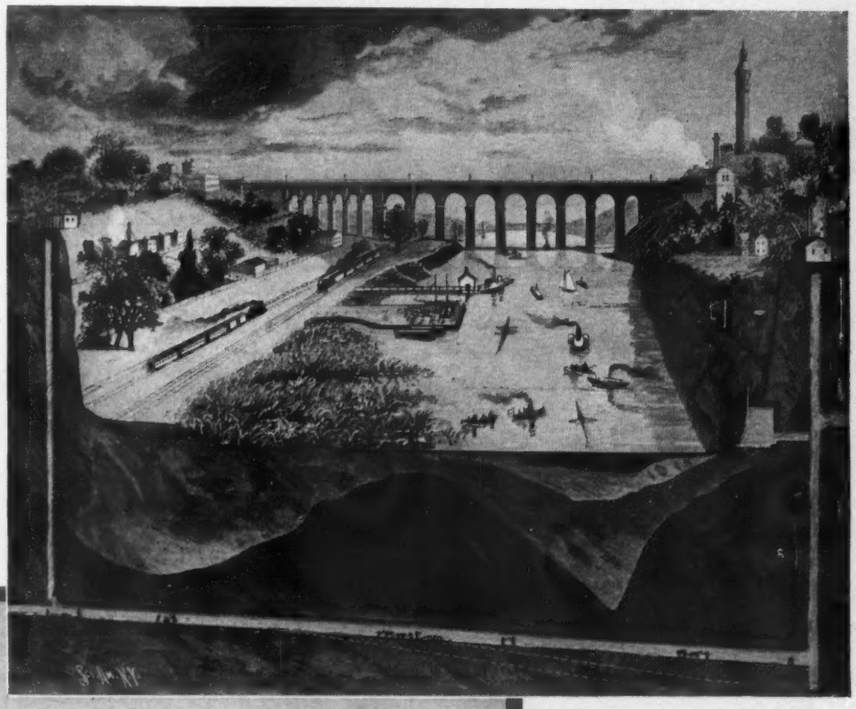
voir sites and aqueduct routes merely by filing on them. This concern proposed to build facilities for delivering 200,000,000 gallons of water per day from the Ramapo River and to charge the city $70 per 1,000,000 gallons under a 40-year agreement.

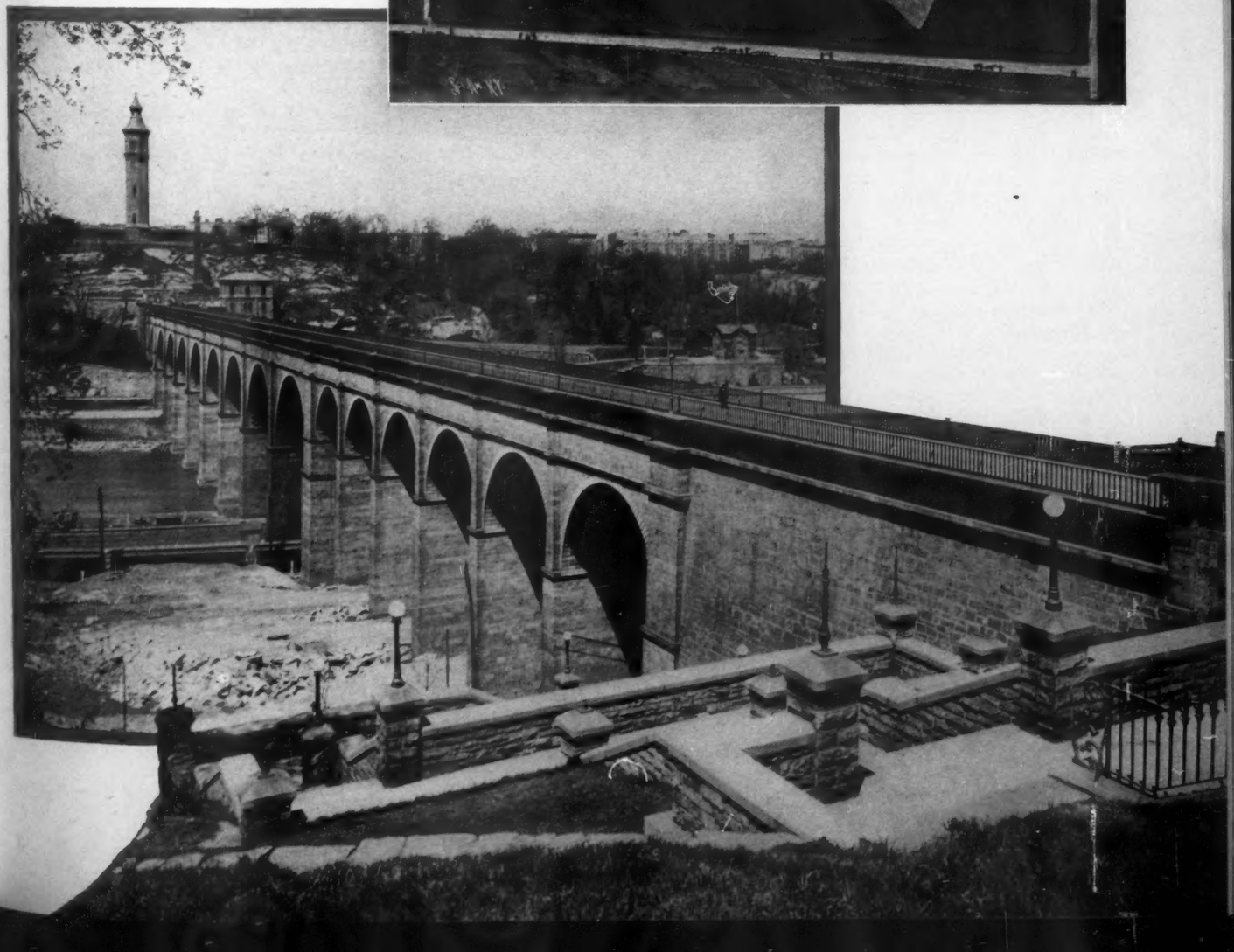
A contract to that effect was suddenly presented to the Board of Public Improvements on August 9, 1899, and would have been approved but for strenuous opposition by two members. They succeeded in delaying final action for two weeks. On the following day when the public learned about what had transpired, a near-scandal was precipitated. Many political heads fell; Gov. Theodore Roosevelt had the charter of the Ramapo Water Company revoked; and a strong movement was launched urging the city to take steps to increase the water supply. The ensuing studies and investigations, extending in all over a period of eight years, resulted in the Catskill water system, which has become justly renowned as one of the world's foremost engineering projects.

The Catskill system was constructed in two stages. The first was started in 1907 and completed in 1917, when 250,000,000 gallons of water a day was added to New York's available supply. It includes Ashokan Dam on Esopus Creek—a tributary of the Hudson River—and an aqueduct leading from the dam to Hill View Reservoir in Yonkers, a total distance of 92 miles. From Hill View Reservoir delivery is made

HIGH BRIDGE AND HARLEM RIVER SIPHON

One of the outstanding structures of the first Croton water works was the High Bridge, on which the aqueduct was carried across the Harlem River to Manhattan Island. It was patterned after the ancient Roman aqueduct bridges and had fifteen stone arches. Even today it remains one of the finest examples of masonry in New York City. In 1860 a wrought-iron pipe, 7 feet 6½ inches in diameter, was added, and the sides of the bridge were built up and roofed over. A few years ago, to facilitate shipping on the Harlem River, three of the central masonry arches were supplanted by one steel arch. The lower illustration shows the bridge prior to this change. At the far end (Manhattan side) was a reservoir that served water users in the Washington Heights section. This was supplemented by a tower that is visible. The latter was 324 feet high and had a capacity of 47,000 gallons. When the new Croton Aqueduct was built, between 1885 and 1890, the crossing of the Harlem was effected by a siphon that reached a depth of 307 feet below sea level. This was considered a bold piece of engineering at the time, as nothing like it had been attempted before, although the ancient Greeks are said to have built such siphons on a smaller scale. A sketch of this siphon, with the High Bridge in the background, is reproduced below.





SHANDAKEN TUNNEL

Interior of the 18-mile bore that carries the water stored behind Gilboa Dam to the Esopus watershed and thence into the Catskill Aqueduct. It was driven almost entirely through rock, and lined with concrete throughout. Its inside dimensions are 11 feet 6 inches high by 10 feet 3 inches wide. Because the Schoharie watershed is subject to heavy floods, the tunnel was built to have a daily carrying capacity of some 600,000,000 gallons, or more than twice the rated average supply.

to the various boroughs, the extreme distance being 27 miles to Silver Lake Reservoir in Richmond Borough (Staten Island). Eighteen miles of line is in the form of a circular, concrete-lined tunnel driven through solid rock far beneath the city's streets.

Fifty-five miles of the Catskill Aqueduct was built by the cut-and-cover method; 17 miles consists of circular pressure tunnels, outstanding among which is a section 3,022 feet long that crosses beneath the Hudson River at elevation −1,114 feet; and inverted steel-pipe siphons constitute 6 miles of the route. As a part of the scheme, Kensico Reservoir was greatly enlarged so as to store a 2-months' supply for the city and thus prevent a shortage in case of failure at any point in the 75-mile stretch between the reservoir and Ashokan Dam.

When the Catskill system was begun in 1907, the population of Greater New York was well over 4,000,000 and growing at the rate of 115,000 persons annually. Thus in 1924, after seven years of service, the aqueduct was carrying 400,000,000 gallons daily, which was the full amount that could be provided under the first stage of the plan. In that year, through the partial completion of the second stage, an additional 150,000,000 gallons a day was made available, and the aqueduct immediately began delivering it. This second stage involved the construction of Gilboa Dam on Schoharie Creek, a tributary of the Mohawk River, and of driving the 18-mile Shandaken Tunnel to convey the water thus impounded to Ashokan Reservoir. When these facilities were put in operation in 1927, there became available 600,000,000 gallons daily, which is the maximum capacity of the aqueduct.

The total cost of the Catskill system, including the delivery lines from Hill View Reservoir to the city, was $188,083,272.45. In 1928, a second delivery tunnel was started in the rock beneath the city to supplement the service of the existing one. It is known as City Tunnel No. 2 and extends for 20 miles at depths of from 100 to 553 feet below sea level. It was finished several years ago at a cost of $58,000,000.

Upon the completion of the Catskill system the supply of water from all sources was 1,039,000,000 gallons per day. Of this total the Catskill can contribute 600,000,000 gallons and the Croton about 340,000,000. The remainder, of which some 30,000,000 gallons is furnished by private companies, comes from wells on Long Island. From its supply the city is obligated to deliver approximately 20,000,000 gallons daily to communities along its aqueduct lines.

From the time Catskill water was first distributed in 1917, consumption increased each year until 1930 at the rate of 30,000,000 gallons per day. In the latter year, 1,007,000,000 gallons was required daily, or only 32,000,000 gallons less than the total dependable supply from all sources. Plans for obtaining additional water had been under consideration since 1921, and by 1927 the Delaware River Project had been drawn up in detail. As mentioned at the outset, the depression necessitated postponing the beginning of construction work. Meanwhile, consumption dropped about 5 per cent, but it is now on the rise again. In 1935 it amounted to 970,000,000 gallons—950,000,000 gallons a day in the city and 20,000,000 gallons outside—which was only 69,000,000 gallons under the available supply.

Because the Delaware River is an interstate stream it was necessary to enter into negotiations with the states of New Jersey and Pennsylvania relative to withdrawing water from its tributaries. Agreements were made in 1925 and in 1927, but in both cases they were not ratified by New Jersey and Pennsylvania. For that reason, the Board of Water Supply recommended that the city develop Roundout Creek, a tributary of the Hudson River, and the tributaries of the Delaware that lie wholly within the State of New York, as follows: the East Branch of the Delaware, Little Delaware River, Beaver Kill, Willowemoc Creek, and Neversink River. It was proposed to carry out these projects in three stages:

First stage—Construction of reservoirs on the Neversink River and on Roundout Creek, together with a connecting tunnel. Construction of an aqueduct from the dam on Roundout Creek to Hill View Reservoir with connections to West Branch Reservoir on the Croton watershed and to Kensico Reservoir. It was estimated that this would make available 170,000,000 gallons daily of new and additional water.

Second stage—As the work just outlined approached completion, construction was to be started on a reservoir on the East Branch of the Delaware and on a connecting tunnel through to the Roundout Valley to divert that water to the aqueduct. It was contemplated that these works would make available an additional 370,000,000 gallons daily and bring the total for the new system to 540,000,000 gallons a day.

Third stage—As more distant developments would be required, the reservoirs on the Little Delaware River, Beaver Kill, and Willowemoc Creek were to be constructed, together with the necessary connecting tunnels, making available a further supply of 160,000,000 gallons daily and providing a total new supply of 700,000,000 gallons daily.

This plan received the needful approvals

CROTON DRILLS

Modern hammer drills are ten to twelve times as effective as the old piston drills.

of city and state controlling bodies, and the necessary legislation permitting construction to proceed was passed by the State Legislature in 1928. At this juncture the State of New Jersey brought an action in the United States Supreme Court to enjoin New York City from diverting water from any of the tributaries of the Delaware. Pennsylvania subsequently entered the case as an intervenor. A Special Master's report was made and led to a decree on May 25, 1931, which limited the permissible diversion of Delaware River water to 440,000,000 gallons a day and left the city free to petition for further diversion at a later time. The quantity of water allocated is the amount contemplated in the first two stages of development, as 100,000,000 gallons of the daily total of 540,000,000 gallons is expected to come from Roundout Creek, a Hudson River tributary. It was further decreed that provision be made for treatment of the sewage of the City of Port Jervis, N. Y., before effecting any diversion, and that compensating water be liberated from reservoirs into the Delaware River system during periods of low water.

It is the construction of the first two stages that is now being undertaken, with the initial work concentrated on the first stage. The dam on Roundout Creek will be located at Lackawack. It will be an earth structure, with a concrete cut-off wall that will be built by the caisson method. The reservoir thus created will have a capacity of 50,000,000,000 gallons. Meanwhile, surveys are proceeding for the dam on the Neversink River and for the tunnel of approximately 3½ miles to connect it with Lackawack Reservoir. The Neversink Dam also will be an earth structure and will form a reservoir having a storage capacity of 30,000,000,000 gallons.

Detailed plans for the 85-mile main aqueduct from Lackawack Reservoir to Hill View Reservoir have been completed, and the route has been diamond drilled at sufficiently short intervals to determine the depth that will have to be attained to keep well in solid rock. It is intended to allow a minimum cover of 150 feet of rock. This tunnel will be circular in section and will be lined with concrete throughout averaging 2 feet in thickness. From Lackawack Dam to West Branch Reservoir, in the northern part of the Croton watershed, it will be 13½ feet in diameter. Provision will be made for carrying some 100,000,000 gallons of high-level Croton water daily. From West Branch to Kensico Reservoir the diameter will be 15 feet, and from Kensico to Hill View the diameter will be 19½ feet. As excavated, the diameters of the various sections will be approximately 4 feet greater than the figures given.

Several reasons prompted the decision to drive the aqueduct entirely in rock. Improved methods of tunneling insure advancing the 85-mile bore with dispatch. Once it is in operation there will be virtually no expense for maintenance and there will be no fear of breaks. By depressing the line throughout its course the expense of obtaining rights of way is materially lessened, it being necessary to secure only underground easements. Construction also is simplified, as surface structures, highways, rivers, and other physical features will not impede progress.

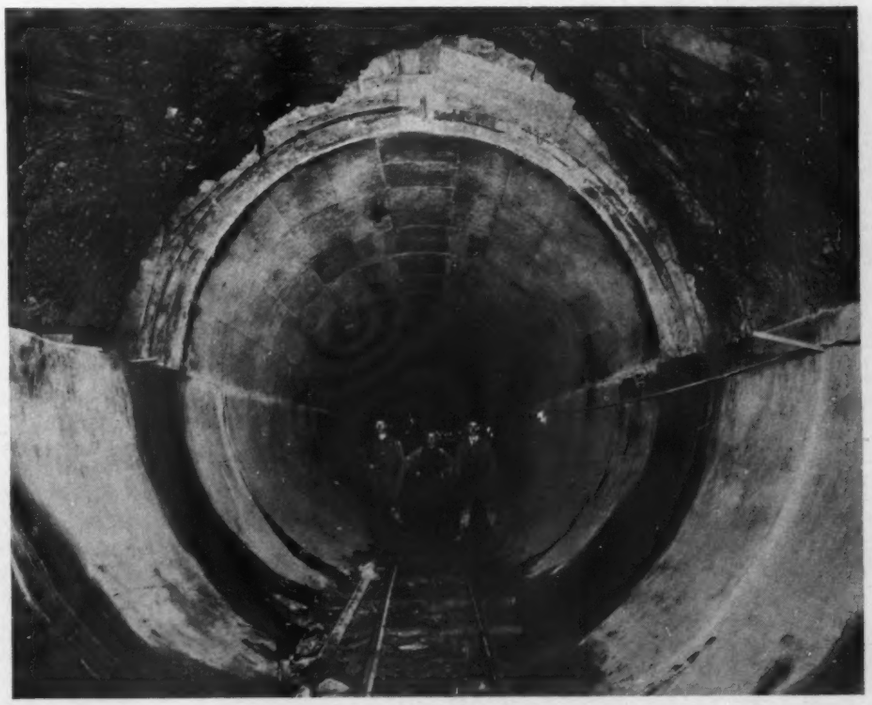
As the carrying capacity of the aqueduct will vary with the head of water in the respective reservoirs it will serve, the engineers are reluctant to assign any definite capacity to it. However, it can be said that the nominal capacity in its upper and smaller section will be around 700,000,000 gallons daily and may at times reach 900,000,000 gallons, as compared with the 600,000,000-gallon capacity of the existing Catskill Aqueduct. Below West Branch Reservoir the new aqueduct will deliver an additional 100,000,000 gallons a day, and from Kensico to Hill View its capacity will be as much as 1,200,000,000 gallons daily. For operating purposes, therefore, Kensico will become virtually a distributing reservoir.

Access to the tunnel grade line will be by vertical shafts that will be sunk at intervals on an average 3½ miles apart. These shafts will range in depth from 310 to 1,550 feet and will have an aggregate depth of 18,000 feet. Three of them will serve as drainage shafts. The largest of these will be elliptical in shape and will have dimensions of 32 feet 2 inches by 22 feet. The remainder will be circular and will vary in diameter from 14 to 19½ feet. At five locations the shafts will be double.

Bids for the sinking of three shafts at the northerly end of the aqueduct and seven shafts at the southerly end were awarded on January 22. The low bidder in each case was the Dravo Corporation of Pittsburgh, Pa., its figures being, respectively, $1,738,250 and $4,108,583. Actual tunnel driving cannot get underway, of course, until shafts are opened to permit access to the grade line and to provide hoistways for the removal of excavated material.

As work proceeds on the first stage, detailed investigations of the second will be made and plans drawn for its execution. It is expected that from seven to ten years will be required in order to complete the two stages.

This monumental piece of construction work is under the direction of the Board of Water Supply of the City of New York. The members of the board are George J. Gillespie, president, Henry Hesterberg, and Rufus E. McGahen. All engineering investigations and the preparation of plans and estimates for the construction are in charge of the engineering bureau of the board. Thaddeus Merriman, who served as chief engineer from 1922 to 1933, handled all the technical problems arising in connection with the court hearings relative to the allocation of Delaware River water, and it was during his regime that plans for the new development were formulated. Mr. Merriman retired in 1933 and was succeeded by Walter E. Spear as acting chief engineer. The latter was appointed chief engineer in 1936 and is directing the work now in hand.



SECTION OF CATSKILL AQUEDUCT

In the pressure tunnel underneath Roundout Creek Valley, showing a section in which the concrete lining has been placed with the exception of the arch in the foreground. The interior diameter is 14¼ feet. The Delaware Aqueduct will be generally similar in construction.

The Oyster Opens Up

Robert G. Skerrett

Photos, U. S. Bureau of Fisheries

THE OYSTER has become communicative, and none too soon to assure its own survival and the continued tickling of our palates. In some ways, the oyster remains just as dumb as ever, but by taking the bivalve into the laboratory, the scientist has latterly been able to discover age-old secrets concerning the life history of the oyster, its intimate habits, and some of its well-defined preferences in the matter of conditions favorable to growth and even survival. These revelations are now being used to save the second most valuable of our fishing industries.

According to statistics compiled by the Government about fifteen years ago, our oyster beds—mainly those on the Atlantic and on the Gulf Coast—yielded annually 30,000,000 bushels of marketable oysters. The industry then gave employment to fully 67,000 people; paid wages each twelve-month amounting to nearly $11,000,000; made a return to the fishermen of about $15,000,000; and the investment in vessels, apparatus, and other property exceeded $17,000,000. Figures issued by the U. S. Bureau of Fisheries a few months ago indicate that our annual harvest of oysters has for some years been around 11,700,000 bushels, and the value to the fishermen has been $5,000,000—just one-third what it was in 1920! While the depression did reduce the demand for this toothsome seafood, the outstanding problem confronting us has been the virtual disappearance of oysters from many previously productive beds. What is more to the point, the industry generally did not know what to do to meet the crisis nor how to better conditions. Even the more progressive of our oyster growers were but little more advanced in some of their practices than the Roman fishermen who cultivated oysters after a fashion for the epicures of 2,000 years ago. A state of affairs not flattering to our boasted native ingenuity.

American Indians, living along the Atlantic seaboard, made full use of the natural beds of oysters centuries before the white man first visited the continent. Surviving mounds of shells bear mute testimony to that fact. In Colonial days, oysters abounded on the coastal beds all the way from the easternmost tip of Maine to the shores of Texas. Today, they are not to be found in commercial quantities on the coast of Maine and New Hampshire; and the oyster bottoms of Massachusetts now yield but a small quantity compared with what they did in pioneer days. Indeed, ten years before the promulgation of the Declaration of Independence the Assembly of East Greenwich, R. I., forbade the gathering of oysters with any instrument other than tongs because of the rapid depletion of the existing beds. Nothing was done in those early days towards restocking the grounds: propagation was left entirely to nature's unassisted processes.

The first constructive move was made by New Jersey about 1810, when small oysters were taken from natural beds and planted

OYSTER BOATS

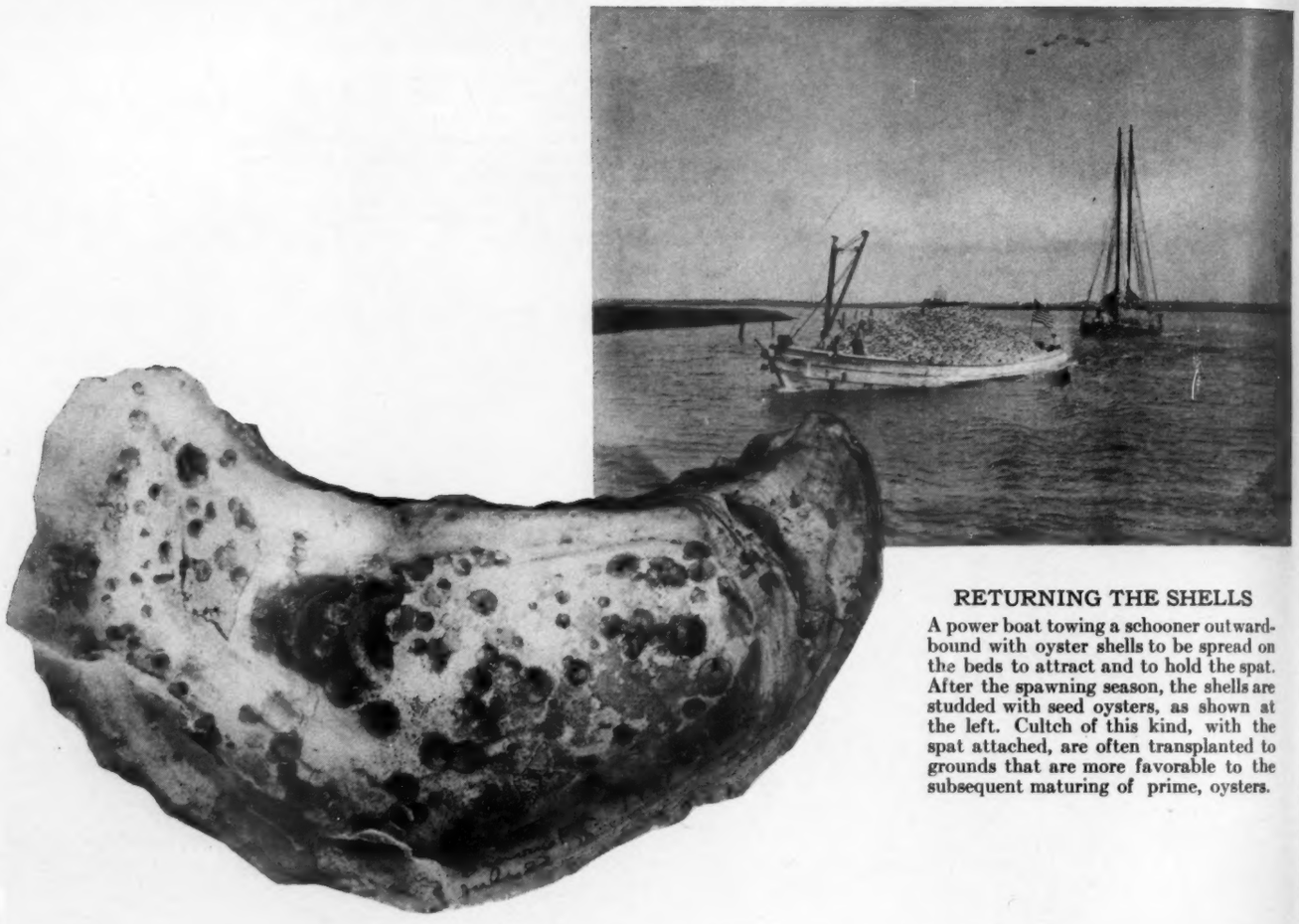
The central picture shows a dredging schooner laden with freshly harvested oysters making ready to discharge her cargo. On either side are pictured fleets setting out for the public oyster beds in Chesapeake Bay. On the beds controlled by the State of Maryland only sailing craft are permitted to harvest oysters by dredging.

on private beds to give them more space and a better chance to develop into large, well-formed oysters. By 1845 the fishermen of Connecticut were actively engaged in doing the same thing, and by 1850 the latter initiated the use of oyster shells, scattered on the water bed, to afford the young or "spat" a suitable surface to attach themselves to and to grow. The shells were first spread on the bottoms of harbors and bays where the water was comparatively shallow. At a later date, shells were similarly planted in the deeper waters of Long Island Sound; and that marked the beginning of an elaborate system of oyster culture which has since become fairly general in the more highly developed oyster-producing areas of the country.

With the exceptions mentioned, the industry of America as a whole, from Colonial days down to a few years back, contributed nothing radical in the way of improving the art of propagating the oyster. How much more the oysterman should know to make his venture a success has been lately revealed by the biologists of the U. S. Bureau of Fisheries, who have worked independently and also in collaboration with state authorities and with some of the progressive oyster growers. Many uncertainties have been cleared up, and a wealth of new and astonishing knowledge garnered that will benefit the industry and the oyster-consuming public.

The oyster has well-defined habits. Along our northern Atlantic Coast it requires from four to five years to reach marketable maturity. In the waters of Chesapeake Bay it arrives at the same stage in three years; and it needs but two years to grow to the desired size in the still warmer waters that wash the shores of our south Atlantic and Gulf states. In Long Island Sound oysters have a spawning period that lasts but two or three weeks, and spawning is not always abundant. In Chesapeake Bay it takes place from May to September, and along the Gulf Coast it begins in March and continues intermittently to November. The northern grower is handicapped by the shortness of the spawning season; and one of the most valuable things that the marine biologist has recently shown him is how he can bring about the "setting" or attachment of the greatest number of the oyster larvae to the shells or to the other mediums that can be used to attract those tiny creatures while they are in the free-swimming stage.

The oysters of the Atlantic and Gulf coasts are individual in sex—the number of the two sexes being approximately equal. Those of our Pacific Coast are different, because the same oyster may be both male and female. The spawning process starts when the water reaches a temperature of 68°F., and attains its normal maximum rate at 70° or more. The eggs from a female may amount to as many as 114,800,000 in the course of a single spawning season, and each has the microscopic diameter of 1/500 inch. They have no apparent power of locomo-



RETURNING THE SHELLS

A power boat towing a schooner outward-bound with oyster shells to be spread on the beds to attract and to hold the spat. After the spawning season, the shells are studded with seed oysters, as shown at the left. Cultch of this kind, with the spat attached, are often transplanted to grounds that are more favorable to the subsequent maturing of prime, oysters.

tion and they are moved hither and thither by the water currents. The male organism is many times smaller, and consists of a nucleus, approximately 1/10,000 inch in diameter, with a thread-like tail about twenty times longer. That tail gives the male organism the capacity to propel itself whither it will within some limits. It was not known until the last few years that the male organism was able to wriggle around.

When the male organism meets and combines with an egg, the latter quickly changes from a single cell into numerous cells and is transformed in from five to ten hours into a small oyster larva that can swim about by means of the filaments on its outer body. Coincidentally, the larva acquires a shell that covers its entire body, and the tiny creature becomes gifted with a definite organ of locomotion, a disk-like appendage that is attached to the end of a stalk that protrudes from between the two halves of the shell. That disk has filaments or hairs which are the propelling agencies, but when it is withdrawn into the shell the larva settles to the water bed.

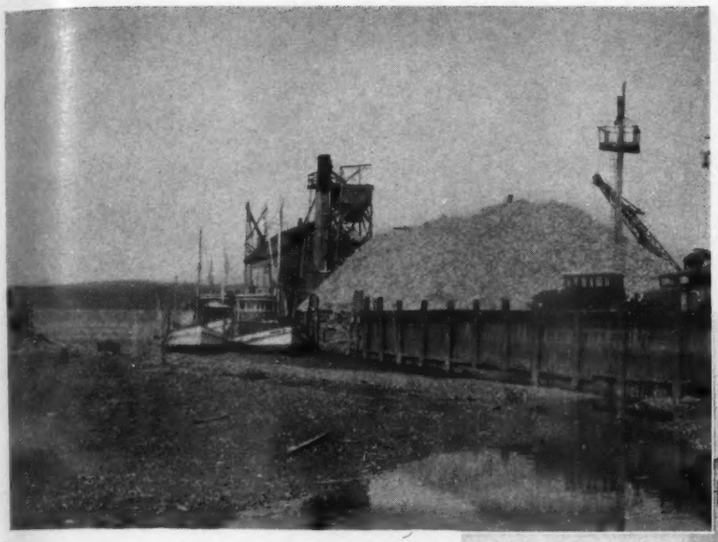
The tiny oyster when two days old has a length of about 31/10,000 inch, and for the next fourteen or eighteen days in northern waters, and for a shorter span in southern waters, the spat is in its free-swimming stage, subsequently attaching itself to a firm, clean surface, if such be available. Therefore, contrary to a long-prevailing belief, the young oyster is not by any means at the mercy of every current nor able to anchor itself merely by chance to a suitable surface. It can exercise a considerable measure of volition; and when the currents approach a velocity of 0.6 foot a second the spat settles toward the water bed where the movement is less pronounced and where it can hold its own. It is this capacity that enables the minute creature to remain close to the bed or ground where it was born—something of the utmost importance to the oyster grower.

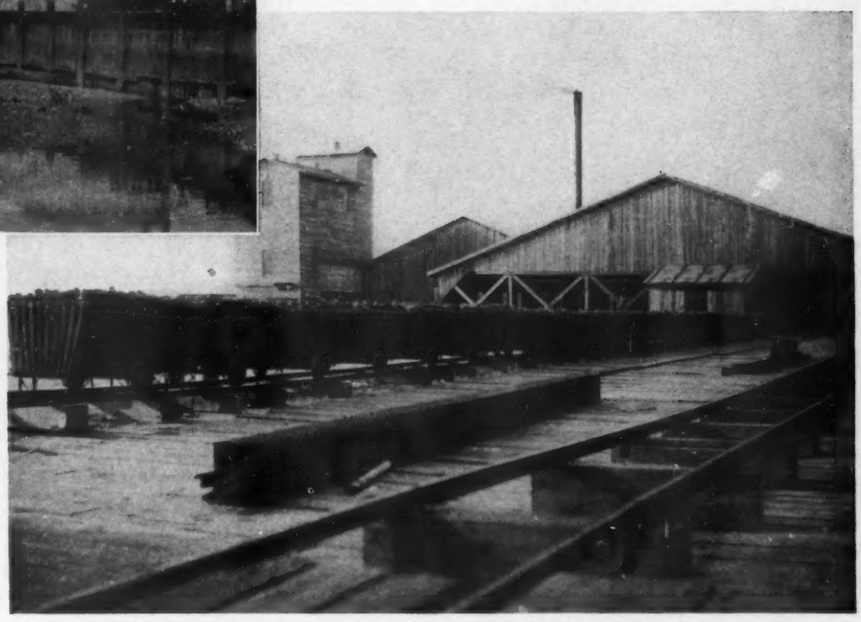
At the end of the free-swimming period the spat is 1/75 inch long and is then ready to "set" or "strike" if conditions be favorable. At that stage it will attach itself to a rock, an oyster shell, or to any other suitable surface—the contact being made by the deeper of its two shells. To effect this, the spat ejects its own cement, which hardens sufficiently in about a minute to afford the required bond; and from that time on, so far as the oyster is concerned, it is established for life. Thereafter the spat changes physically in some particulars and acquires the organs of the familiar oyster, and in the course of two weeks has increased in length to ¼ inch. It is then started upon the life cycle that eventually makes it the marketable product that we find pleasing to our palates.

In northern waters the oyster farmer's success hinges primarily upon his obtaining an abundant crop of the spat just described. The young oysters prefer a bottom that will afford a suitable anchorage, and where tidal movements keep it swept clean and bring to the bivalves the food essential to their sustenance. The farmer subscribes to these conditions so far as practicable; and in preparing the water bed for the expected spat he scatters oyster shells on it to encourage the little creatures to set.

The shells with the seed oysters attached are recovered subsequently and transplanted, if that be the intention, or left undisturbed until the oysters have attained marketable size. Transplanting is done when they are from a few months to two years old; but shifting is seldom done if the spat have grown to a length of 1½ inches. Because several hundred may anchor themselves to a single shell during a heavy spawning season, seed oysters should be harvested as soon as they are large enough for transplanting. This prevents crowding, deforming, and undernourishing the bivalves which, when separated and planted where they will have ample space, have every chance to develop into large, fat, well-shaped oysters.

Oysters, it has been noted, have a tendency to arrange themselves in greater numbers at higher levels on a stick or pile standing submerged on the water bed, and this fact, interpreted lately by marine biologists, has opened the way for the planter to revo-





OYSTER PROCESSING PLANTS

Approximately 60 per cent of the oysters sold each year are shucked before they reach the market, and extensive plants have been established for handling them. The picture above shows a landing dock at one of these plants and a great pile of oyster shells. At the right is a train of cars, laden with oysters, ready to be run into a cannery.

lutionize one of his practices and considerably to increase the abundance of his set, especially in waters where the spawning season is normally a short one. In northerly waters the oyster shells, or "cultch," are distributed at the rate of from 500 to 1,000 bushels per acre several months before the spawning season. Storms, freshets, etc., may carry silt to the grounds and cloak the shells so that the oyster larvae cannot attach themselves to them. Here is where the marine biologists have taken a priceless hint from the revelations of oyster-covered piles and have devised ways either to use the shells to better advantage or to employ other forms of cultch not likely to be blanketed by silt and offering the spat more expansive surfaces to anchor to.

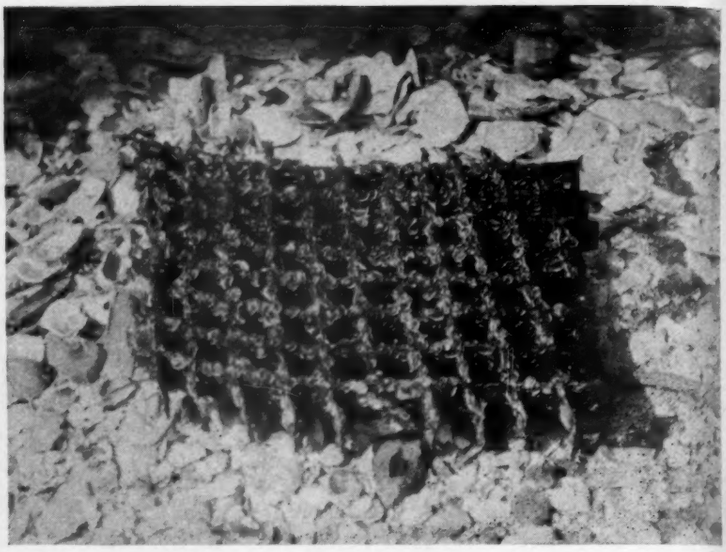
The shells are placed in bags or collectors. Some of these are fabricated of the familiar chicken wire or mesh and are 1 foot in diameter, 3 feet long, and capable of holding a bushel of shells. Others that have also proved effective are in the form of wooden lattice crates, while still others—fashioned of interlocking strips of waterproof cardboard like the partitions of an egg box and coated with a mixture of cement, lime, and sand—have been found especially satisfactory because the accumulated spat can be separated easily by breaking the partitions apart with a minimum of damage to the seed oysters. This is of importance to the grower, as the loss is far lower than when the spat have to be detached from oyster shells.

The various collectors can be arranged in stacks so as to intercept a much larger percentage of the free-swimming larvae than is possible when the cultch is lying properly distributed on a clean water bed. Should spawning be found deficient in one area, the collectors can readily be lifted out of the water and shifted to other grounds where it has been ascertained to be good.

The marine biologist can foretell with reasonable certainty a month or so in advance when the oysters of a given bed are going to spawn; and the best results for the planter can be obtained by placing the collectors on the grounds just before spawning time. He can foretell also whether spawning will be abundant or meager. Science has thus removed many of the difficulties that have hitherto beset the oyster farmer; and from now on much of the gamble of the past should be succeeded by an encouraging measure of success.

This applies equally to the oyster industry on the Atlantic and Gulf coasts and to the expanding industry on the Pacific Coast, where transplanted Japanese seed oysters, in addition to the small native Olympia, are being grown to marketable size in increasing numbers. In 1925, Japanese oysters worth $16,000 and representing 28,000 pounds of meats were marketed; and in 1934, meats of the same kind valued at $359,475 and weighing 4,956,300 pounds were disposed of—most of them having been brought to maturity in the waters of Puget Sound where the temperature is never high enough to promote spawning and local propagation. The necessary seed oysters are annually imported from Japan; and it takes three or four years for them to reach maturity after transplanting.

The marine biologist, by taking the oyster into the laboratory, has found out, among other things, how often the creature eats; that it drinks or passes through its gills as much as 100 quarts of water in 24 hours during its most active periods; when the bivalve is at its best; what is the nature of its food; and what must be the constituents of a satisfactory diet. To flourish, to reach and maintain a prime condition, the oyster requires iron, copper, and manganese. It also carries a definite percentage of calcium, phosphorus, and iodine. In brief, biochemical studies have disclosed that it contains appreciable quantities of all the minerals we need to promote the healthy functioning of our bodies—that it can provide us with valuable percentages of vitamins A, B, C, D, and G. In other words, nature has made the oyster a nearly complete food; and wherever the local or territorial diet is deficient in iodine, where goiter is prevalent, the eating of oysters will prove a safeguard as well as a corrective. It is authoritatively asserted that the oyster can be eaten during any month of the year and



HOW YOUNG OYSTERS CONGREGATE

Study of the habits of oysters reveals many important facts that can be put to use in aiding their culture. The view at the left shows the zonal clustering of young oysters well above the foot of a pile and indicates their preference for anchoring above the bottom where the water has a clear sweep. Above, an egg-crate type of collector that was put down on the water bed with a multitude of seed oysters clinging to it.

for any meal of the day, and further, that it is an economical food because all its meat is edible.

Oysters are harvested by hand tongs or hinged double rakes, by patented tongs, by dredges in the form of open-mouthed broad rakes with mesh baskets which may be lifted manually or by hand-operated windlasses, or by bigger dredges that are raised to a vessel's deck by means of a power-driven windlass or hoister. Hand-tonging is a tedious, wet, and at times risky job, and the average small boat and crew of two men can harvest in a working day only a comparatively few bushels. Oyster schooners or kindred-sized craft, equipped with an auxiliary motor, can dredge a much larger number of bushels a day; and there are several steamers, operating on private grounds, that are each capable of dredging as many as 8,000 bushels daily. The dredges used by these vessels are each big enough to scrape up as many as 30 bushels at a time. On public grounds, dredging is either much restricted or prohibited—most of the bivalves being recovered by the aid of hand tongs which are not so likely to overbalance nature's propagating processes.

Oysters reach the consumer either in the shell, shucked, or canned; and the canned product has in latter years taken various forms. Those shipped in the shell are usually packed in barrels, sometimes in sacks, but in either case without ice. When they are dispatched long distances, however, such as to the Pacific Coast, they journey in refrigerated cars. Select grades are also carried abroad. Probably 60 per cent of the oysters distributed in the fresh trade are shucked before marketing, and it is estimated that 5,500,000 gallons of shucked oysters are sold annually.

Shucking, even by people regularly employed in the work, results in injury to the meats of from 5 to 10 per cent of the oysters because of the difficulties offered by the tightly closed shells. The U. S. Bureau of Fisheries has devoted considerable research to the problem, and its experts have discovered that certain cheap, tasteless, non-injurious chemicals can be used in the washing water to cause a narcotic action that will induce the oyster to relax its strong closing muscle sufficiently to lead to a slight opening of the shell. At least, that has been done in the laboratory; and perhaps some day it can be applied on a commercial scale and reduce a loss which the ultimate consumer must pay for.

Before the shucked oysters are packed for shipping, it is essential that they be cleaned and freed of sand, bits of broken shell, and other foreign matter. In this important operation compressed air is extensively employed to agitate the washing water and thus to tumble the meats and to rid them of dirt and slime. When cleaned and lifted clear of the washing water and drained, they are packed usually in cans of 1-quart and 1-gallon capacities, although 3- and 5-gallon cans are used occasionally. In the manufacture of these containers compressed air is employed; and it also serves in testing them for tightness. When filled and sealed and when they are to be shipped long distances, the cans are packed in ice to assure keeping the contents fresh while in transit. Large quantities of oysters are steamed and canned, and minced cooked oysters are also packed for distribution, while oysters dried by a vacuum process are made into a powder that can be utilized in producing broths and soups.

Oyster shells are a by-product of much commercial value and are used mainly in three ways: to reshell oyster beds; to be crushed for marketing as poultry grit; and to provide lime for different purposes—for soil improvement in agriculture, for example. The latest application is said to be in the manufacture of cellophane, because oyster-shell lime is of exceptional chemical purity. Thousands of tons of waste oyster shells were formerly employed in roadbuilding, but they are too valuable now to be disposed of in that way.

Since the marine biologist has discovered how better to propagate seed oysters and to restock depleted grounds he has centered much of his attention on ways and means to offset the physical conditions that endanger the oyster from time to time and to combat the starfish, screw borer or drill, the drumfish, the conch, and some worms that annually have taken and still take a heavy toll of the bivalves, both young and mature. Progress is being made in this defensive work. Certain it is that the industry as a whole is now fortified with a wealth of information that will make it practicable for growers to restock their beds, to widen their productive areas, and to provide oysters in sufficient quantity to meet an increasing demand instead of being confronted by the possible extermination of this invaluable seafood.

Sinking a Coal-Mine Ventilating Shaft

William S. Powell

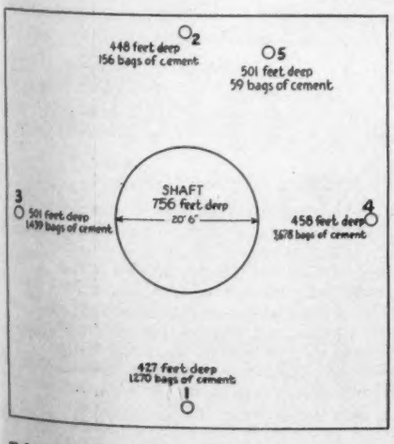
GENERAL VIEW

The various buildings served as a compressor house, machine shop, warehouse, etc.

TO FACILITATE the expansion of its workings in the southern West Virginia coal fields, the Carter Coal Company is constructing a new ventilating shaft through which enough air can be supplied to its Olga No. 2 Mine to increase the daily output of coal from 4,000 to 6,000 tons. The shaft is 20½ feet in diameter and 756 feet deep, and will be the largest for the exclusive purpose of ventilation in the Pocahontas field. It is square in section at the top, tapering a few feet below the surface to circular form. The Olga No. 2 is at Caretta, W. Va., 4 miles from Coalwood, and the new shaft is the fourth to be sunk at that mine. The others include a circular ventilating shaft 17 feet in diameter, an oval manway and material shaft with an area of 319 square feet, and a main hoisting shaft covering 229 square feet.

Work on the new shaft was started on June 22, 1936, and the opening connecting it with the mine entry at the bottom was cut through on January 15, 1937. The total time required for this phase of the operations was 208 days, and the average daily progress was a little more than 3.6 feet. Officials are of the opinion that this constitutes a record for shaft-sinking in that part of the country. It is certain now that the over-all construction period will be several months shorter than was originally estimated. The rapid progress can be attributed to the efficient methods and equipment that have been employed, as well as to the thoroughness with which the operations were organized. As a result of the saving in construction time there will, of course, also be a considerable saving in cost, taking the original estimate as a basis.

Naturally, in sinking any shaft, the methods adopted depend largely upon the formation encountered. For this reason the area around the proposed shaft is core-drilled to ascertain just what is beneath the surface. If the material is found to be solid and dry and made up principally of rock, the problem becomes a comparatively simple one. If, on the other hand, the material is water-bearing and soft and likely to run into the bottom of the shaft as it is being excavated, then it will be only a question of time before the ground around the shaft will begin to shift and, consequently, exert an unequal and disastrous pressure. Voids outside of the true section of the excavation inevitably invite and bring about pressures which in many cases cannot even be estimated, and for that reason every precaution must be taken to prevent soil movement.



LAYOUT OF GROUT HOLES

To consolidate the ground through which the shaft was to be sunk and thereby to prevent the inflow of water, five 6-inch vertical holes were drilled within a radius of 20 feet from the outside line of the shaft. These were carried well below a known water-bearing horizon about 300 feet down from the surface. Into these holes cement grout was forced under pressure, the work being done by a company that specializes in the cementing of oil wells. A total of 6,602 bags of cement was injected, the quantity varying widely with the different holes. Provision had also been made for constructing drains to carry downward any water that might penetrate the grout curtain; but it was found unnecessary to install these.

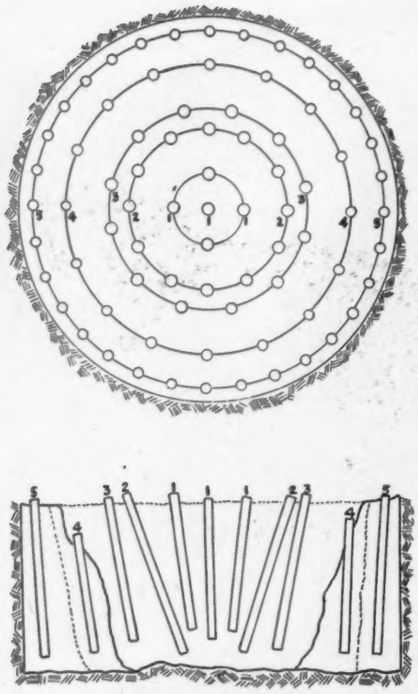


DIAGRAM OF DRILL HOLES

A typical drilling round was made up of 77 holes, disposed of as shown at the top, left. In the center of the shaft were drilled five "busters," (No. 1). About 2 feet from these, twelve "sump holes," (No. 2), were placed in a circle. Just outside of these, and staggered in relation to them, were put down twelve "kickers," (No. 3). Arranged in a circle about a foot from the outside line of the shaft were drilled 16 "relievers," (No. 4). Finally, 32 holes were placed as close to the outside edge as possible. The blasting order is shown in the lower sketch. Holes numbered 1, 2, and 3 were shot first, in the sequence mentioned, and the resulting muck was removed. The heavy, slanting lines indicate the shaft section as it then appeared. Number 4 holes were next fired and the material mucked out. The section then had a form somewhat as shown by the dotted lines. The No. 5 holes were shot last and the muck excavated.

The formation which was encountered in sinking the Caretta shaft consisted for the most part of sandstone and shale. To begin with, the drillers penetrated about 51 feet of sandstone and ran into a 1-foot seam of coal. Then followed successively 4 feet 7 inches of shale mixed with fire clay, 64 feet of gray sandy shale, 16 feet of sandstone, 18 feet of hard sandy shale, 3 feet of coal, 4 inches of dark slate, 2 inches of coal and bone, 10 feet of dark sandy shale, 33 feet of sandstone, 1 foot of coal, 6 feet of dark shale, 31 feet of hard sandstone, 10 feet of dark shale, 34 feet of sandstone, 7 inches of coal, 5 feet of shale mixed with fire clay, 39 feet of sandstone, 2 feet of coal, 1 foot of shale mixed with fire clay, 17 feet of sandstone, 1 foot of dark shale, 6 inches of coal, 3 feet of shale mixed with fire clay, 44 feet of hard sandstone, 4 inches of coal, 1 foot 6 inches of sandstone, 6 inches of coal, 3 feet 8 inches of shale mixed with fire clay, 35 feet of hard broken sandstone, 2 feet of dark shale, 87 feet of sandstone, 57 feet of dark shale, 1 foot 6 inches of coal, 5 feet 6 inches of shale mixed with fire clay, 65 feet of hard sandstone, 18 feet of dark shale, and 20 feet of sandstone. Underlying this is a 7-foot coal seam, the level at which the new shaft was terminated.

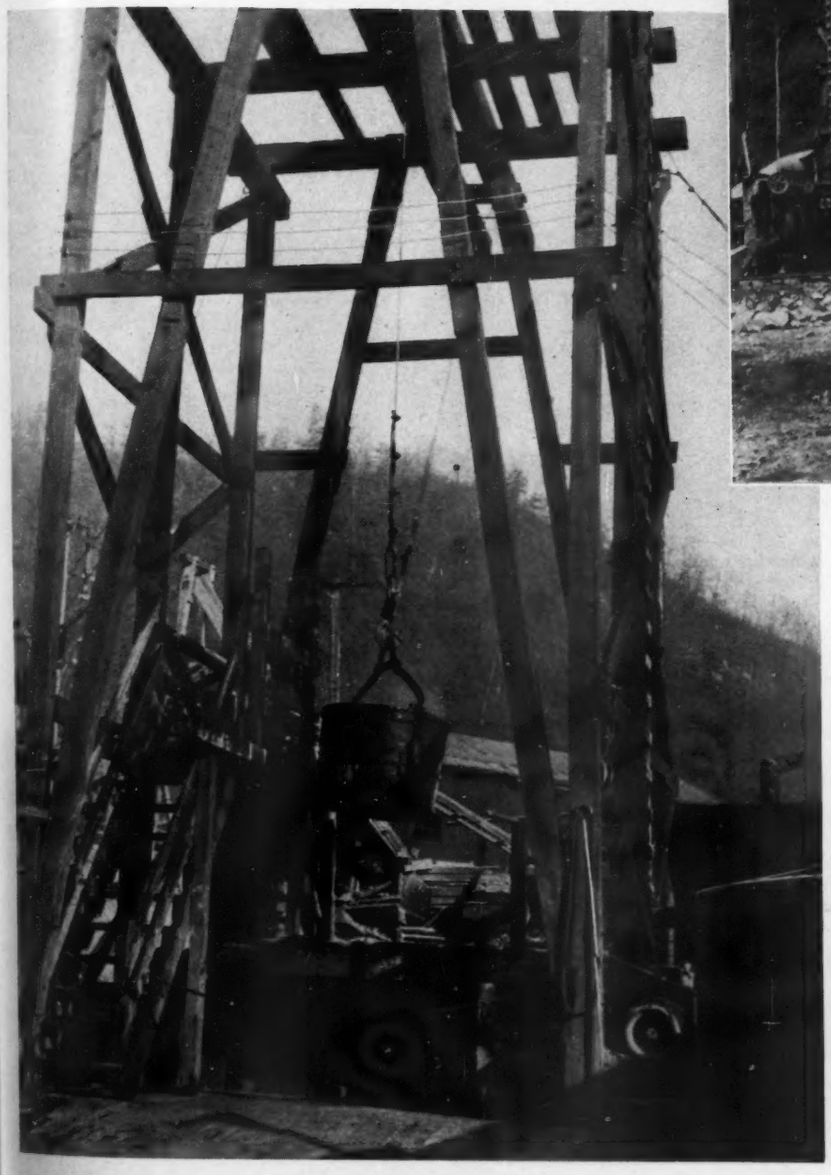
One of the greatest hindrances to shaft-sinking in southern West Virginia is water. The problem is how to handle the ground water encountered there at a depth of about 300 feet. Invariably, if a shaft is carried below that level serious difficulties are experienced. Several years ago it took approximately two years to sink a shaft at the Carter Coal Company's No. 1 Mine. The engineers have tried a number of things in an effort to overcome the difficulties; but the methods recently employed in the case of the Caretta shaft are probably the most satisfactory that have ever been applied.

Before excavating was begun, five 6-inch grout holes were put down with a churn drill within a radius of 20 feet from the outside rim of the proposed shaft and drilled to depths of 448, 501, 427, 458, and 501 feet, respectively. Into them was pumped cement grout under pressure, completely filling all the seams, small voids, and crevices as it went down. The entire area was thereby sealed off and, as a consequence, no water to speak of seeped into the shaft after excavating was started. The only noticeable water was that encountered at the 84-foot level, but the engineers are of the opinion that that was surface water.

As an added precaution against moisture, and to insure a dry hole, provision was made for eight tile drains at equidistant points around the outside of the shaft. In the event water should enter, despite the grouting done, it could then be made to run off toward the sides of the shaft and on down to the bottom where it would be caught in a basin and pumped out through

GROUTING OPERATIONS

Grouting of the ground in advance of shaft-sinking cost $10,000, but the expense proved to be a good investment. Grouting was done with the aid of special truck-mounted equipment capable of handling fifteen bags of cement a minute. In the foreground of the picture above is shown one of the pipes through which grout was introduced. It was capped, following completion of the work at that point. Hose lines can be seen leading from the truck to other grout holes.



HEADFRAME

A temporary timber headframe was erected over the shaft location, with a sheave at the top for the bucket cable which was operated by a surface hoist. All excavated material was raised in the bucket shown. It was dumped into mine cars running on rails and hauled either to a dump or to a crushing plant where the sound rock was reduced for use as aggregate in concrete. In the picture at the right is seen a loaded car and, at the left of the headframe, the concrete mixer required for the work of lining the shaft.

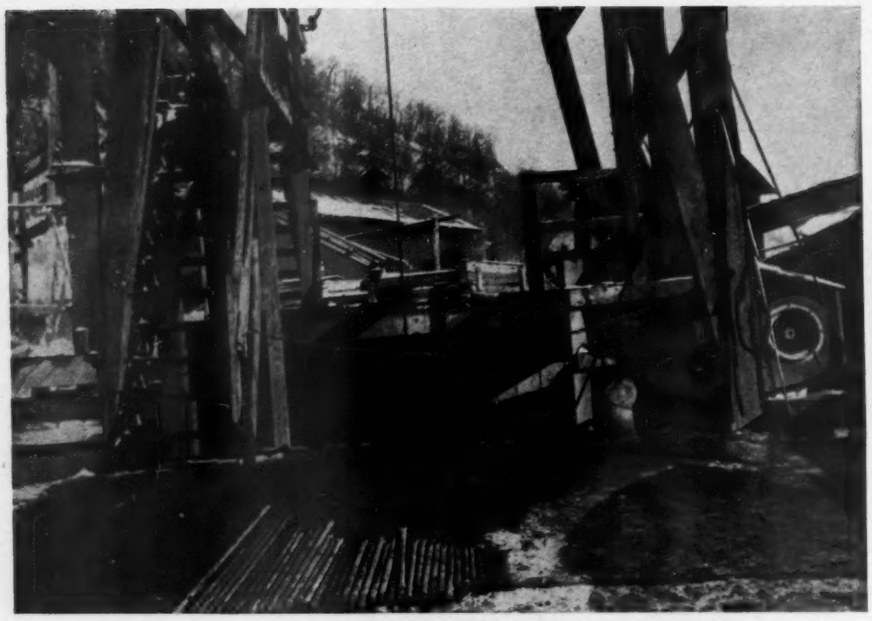
the mine entry. It has not been necessary, however, to install these drains because the grout seal has effectually held the water in check.

It will be observed that all the grout holes were drilled to a depth much greater than the 300-foot water stratum. A total of 6,602 bags of cement was required for the work. The amounts needed for the respective holes varied because of the differences in the ground formation at the several locations. In one instance, the cement that was pumped down into a hole emerged at a point on the hillside several hundred feet below it. In the four remaining ones, however, it stayed underground.

Grouting alone cost approximately $10,000; but the officials of the company are of the opinion that if this had not been done the total cost of the shaft would have been greatly increased. Sealing off the area also made it possible for shaft-sinking to proceed at a much greater speed than would otherwise have been the case. Grouting was done by the Halliburton Oil Well Cementing Company of Oklahoma City, Okla., and Charleston, W. Va., which specializes in cementing oil wells. The equipment employed was designed by that concern. It was mounted on a truck and handled fifteen bags of cement a minute. In service, the bags are pushed across a large blade which cuts the cloth, after which the cement is dumped into a small mixing plant. Water is automatically introduced through a valve, 9 gallons being used for each bag of cement. After being thoroughly mixed, the grout, on this particular job, was pumped through hose into 6-inch pipes inserted in the grout holes. The tops of the pipes were later capped.

After the area had been completely sealed off, excavating was begun. Including the spaces for the arches, which it is necessary to construct at the bottom of the shaft, there has been removed a total of approximately 10,500 cubic yards of material. As the shaft proper connects with one of the main entries of the mine, the arches have been designed with curves that will permit the air to flow into the entry with the least possible resistance. It is expected that the work on the arches will be finished around February 20.

All drilling was done with Ingersoll-Rand S49 Jackhamers, and 1-inch hollow hexagon steel was used. Air for operating the drills was furnished by a Type XRB 17&10½x12-inch, belt-driven stationary compressor having a capacity of 790 cfm. Holes were drilled to a depth of about 8 feet and loaded with 40 per cent dynamite.



THE SHAFT MOUTH

In the foreground is a supply of sharpened drill steel ready to be sent below. At the right is the blower that furnishes air to the shaft workers through the pipe leading from it. When the shaft is completed, a fan will be installed at its top. This will force 600,000 cubic feet of air per minute into the mine workings. Only one-third of that volume will be required at the beginning, but gradually increasing quantities will be needed as the mine is extended. This is the second ventilating shaft to be sunk on the property.

One of the accompanying diagrams shows a typical drill round.

The muck was removed from the shaft by the aid of a bucket which was lowered and raised by a small hoist installed at the top. The drilling and mucking crew consisted of from eight to ten men and worked on a 7-hour shift. Ventilating air during shaft-sinking was provided by a blower at the surface, approximately 1,200 cfm. being introduced through a 12-inch-diameter Ventube.

The spoil was disposed of by means of dump cars that ran on rails and were hauled by two hoists mounted some distance from the shaft. Rock suitable for concrete aggregate was segregated for later use in the shaft-lining operations, a crushing plant on the property reducing it to the required sizes.

The hoist that served to operate the shaft bucket is equipped with 1,000 feet of 1-inch, 18x7 nonspinning Monitor silver-strand steel cable which was manufactured by the American Steel & Wire Company and furnished by the Banks-Miller Supply Company of Huntington, W. Va. It is so made that a free load suspended on the end of a single line is prevented from rotating or spinning. Six strands of seven wires each, left-lay lang-lay (wires in the strands and strands themselves wound to the left), are laid around a hemp core. These strands are then covered with an outer layer composed of twelve strands of seven wires each, left-lay regular-lay (wires in the strands twisted to the right). The breaking strength of the wire rope is estimated at 38.8 tons.

The shaft has been lined with concrete. This work proceeded with the excavating and was done in 30-foot sections with steel forms. The practice was to carry the shaft down 30 feet and then to drill and blast an additional 10 feet. The forms were next placed and the concrete poured. While the concrete was setting, the additional 10 feet was mucked, and by the time that was completed the steel forms could be removed. Much time was saved by this procedure. The forms employed had small doors through which the concrete was introduced, and a small oblique opening at the top of each permitted filling the space above the doors when the concrete had reached that level.

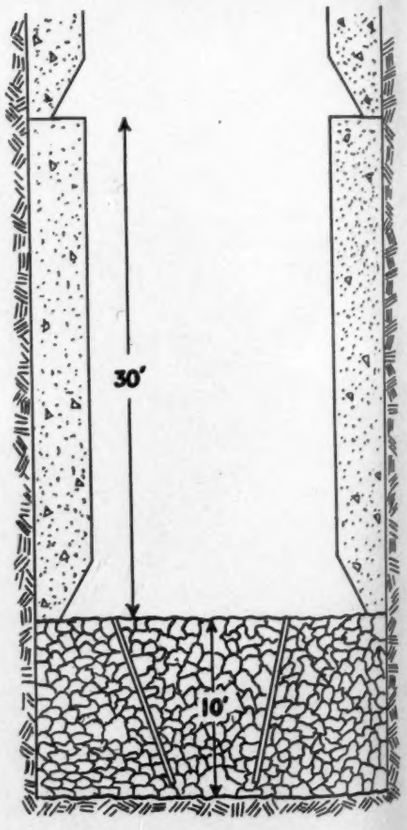
Water for the various operations has been pumped from a deep well that was drilled on the shaft site not far from the points of use. To provide electricity it was necessary to tap a high-tension wire in the vicinity and to build a small transformer plant for the purpose of stepping down the current to the required voltage.

Upon its completion, the shaft will convey to the mine entry a maximum of 600,000 cfm. of air circulated by a large fan that is to be installed at the top. For the present, however, only 200,000 cfm. will be needed. The new shaft is, of course, an intake shaft. It was at first proposed to construct an outlet shaft also, but the engineers decided that this would not be necessary at present. Olga Mine No. 2 was first opened in 1923, and has since been rapidly developed. Its main entry penetrates Pocahontas No. 4 Coal Vein.

The Carter Coal Company operates mines in the Pocahontas, Sewell, and War Creek seams in McDowell County, West Virginia, and in the Seaboard seam in Tazwell County, Virginia. The annual output amounts to more than 3,000,000 tons. Officials of the company have estimated that there is enough coal on the properties to last 50 years at the present rate of production.

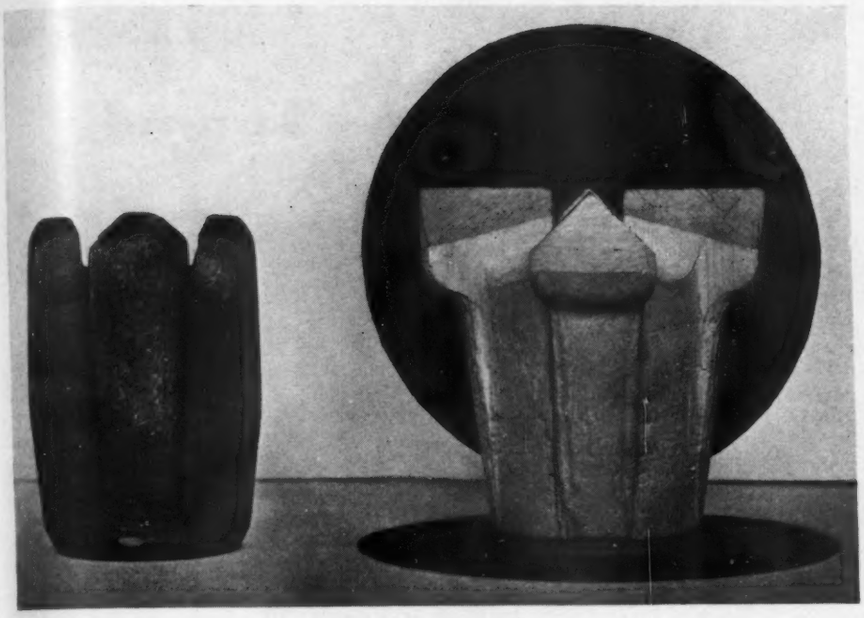
The coal camp at Coalwood and Caretta has a population of approximately 7,000 persons. Most of the miners live in houses which have been provided by and are maintained by the company. Many, however, live outside of the camp and travel to and from their work by means of automobiles and buses. The camp is situated on a branch line of the Norfolk & Western Railway in the heart of a high and rugged mountain range.

G. R. Jennings, general superintendent of the Carter Coal Company, is in charge of the shaft construction. Assisting him is R. A. Van Dyke, chief engineer of the company. The sinking operations were under the direction of Dean Luther, who has had wide experience in this kind of work in different parts of the United States.



LINING SKETCH

Concrete lining was placed in 30-foot vertical sections and with the use of metal forms. After 30 feet of shaft had been excavated, an additional round of holes was drilled and blasted. The 30-foot section was then lined, and while the concrete was setting, the broken rock below it was removed. By the time this was completed the forms could be taken down and further drilling and mucking done.



AFTER AND BEFORE SERVICE

These views show the same Jackbit. On the right it appears in its original form, with 2½-inch gauge. On the left it is shown as it looked after drilling 17 feet in vug-filled chert. Its gauge was then less than 1¾ inches. At the bottom of the page are pictures of the top of the bit.

Solving a Vexing Drilling Problem at Picher-Joplin

W. Murray Ross

MUCH activity again prevails in the Picher-Joplin area, where nearly 100 mines are producing lead and zinc ore. In addition, a number of mills are reworking dumps of old tailings and recovering from them considerable lead and zinc.

The ores in this field occur mostly in layers of chert or flint that are interbedded with layers of dolomite. The chert or flint is filled with vugs or cavities that vary from the size of peas to large openings occupying much space. These cavities are frequently lined with crystals of calcite and galena and, when exposed underground, present a very striking appearance. They also considerably complicate the drilling problem.

The cavities are so numerous and so closely spaced that a drill runner rarely is able to drill a straight hole: they deflect the steel to such an extent as to make its withdrawal exceedingly difficult. It is common practice for operators to back their drills out at full throttle to withdraw the steel the full length of its feed. Further withdrawal is accomplished in many cases only by driving it back with blows from 10- and 12-pound sledges, the steel being rotated during this operation. The drilling problem is further complicated by the extremely abrasive character of the ground, which often grinds as much as ¼ inch from the diameter of machine-sharpened bits during the 24-inch run of steel almost universally used in the district. But the cherty rock, although very hard and abrasive, is also very brittle, and can generally be drilled at the rate of 10 to 12 inches per minute.

To meet these difficult and exceptional conditions, Ingersoll-Rand Company, in collaboration with C. W. Nicolson, manager of the Mary M. Mining Company, one of the important producers in the district, has developed a special 2½-inch-gauge Jackbit that is giving successful results. As shown in an accompanying illustration, this bit is of rather unusual shape.

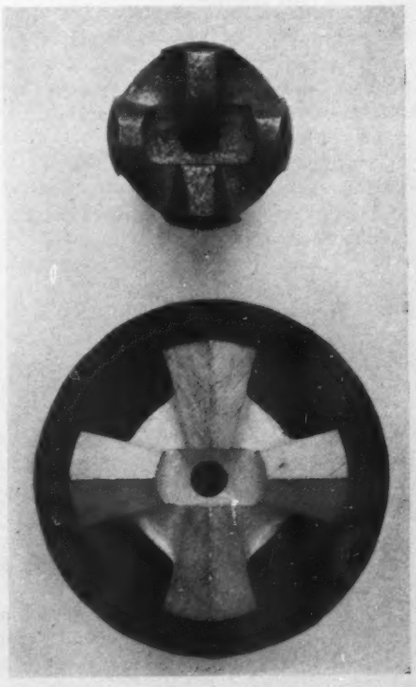
Experience has led to the recommendation that a short jumper or starter steel, with a 4- or 6-point bit larger than 2½-inch gauge, be first used. The purpose of this initial steel is merely to provide a level face preparatory to starting the hole. Once the hole has been collared, drilling proceeds with the shortest Jackrod and the special 2½-inch bit; and this one bit is progressively changed to each of the series of longer rods until the hole is bottomed.

After completing one hole the bit is put back on the shortest Jackrod and the procedure is repeated until the bit is worn down to about 1⅞-inch gauge, when it appears as is shown in one of the accompanying illustrations. Meanwhile, it will have drilled from 8 to 10 feet of hole in the hardest chert. In more free-drilling rock, as much as 60 feet has been obtained from one bit, and the average is around 18 feet. During its entire run the drilling speed of the bit remains about the same; and whatever decrease might be expected because of blunter cutting edges is apparently compensated for by the gradually lessening diameter of the hole being drilled.

One advantage of this practice is that, for a given size of starting bit, holes are materially larger at the bottom than when drilled with the conventional number of bit changes. This, in turn, makes it possible to use greater powder charges and, as a consequence, a greater tonnage of ore is broken per foot of drill hole. This is attributable, of course, to the fact that the only reduction in hole diameter is that occasioned by the wearing of the bit, whereas when bits are changed, each one is slightly smaller than the preceding one and there is a corresponding loss in hole size.

Another advantage of using one bit for an entire drill hole is that all the steel represented by loss of gauge goes into producing that hole. With changes of bits, on the other hand, the reconditioning of each dull one entails a loss of from 1/16 inch to ⅛ inch in gauge. The aggregate loss frequently amounts to as much as ¼ inch for a 10-foot hole.

Ingersoll-Rand Company does not advocate the use of these bits except in very brittle rock that shatters freely and that is extremely abrasive. It is believed, however, that all rock-drill users will be interested in learning of the unusual drilling conditions in the Tri-State field and in the solution of the problem presented by them.



Mono Craters Tunnel

T. E. Daniels

UNDERGROUND SPRINGS

A view at Heading No. 1, which is being driven from the west portal. Water flows, ranging from 150 to 5,000 gpm., have been encountered at various points and have added to the difficulties of maintaining rapid progress.

AMONG the major engineering projects now underway in the United States, the Mono Craters Tunnel, being driven by the Bureau of Water & Power of the City of Los Angeles, Calif., is outstanding as an example of the present-day spirit of patience, perseverance, and progress. Subterranean water, carbon-dioxide gas, quicksand, volcanic ash, shifting ground, and volcanic tuff are numbered among the natural barriers that have been encountered and successfully overcome.

The tunnel is one link in a system that is designed to increase the water supply of Los Angeles. A conduit will intercept mountain streams that now empty into Mono Lake, which lies just east of Yosemite National Park, and carry the water to a catch basin known as Grant Lake Reservoir. This reservoir will provide 49,300 acre-feet of storage. From it the water will flow by way of an open canal to the west portal of Mono Craters Tunnel and, after passing through that bore, will empty into the Owens River. About 50 miles downstream it will be diverted into the existing Owens Valley Aqueduct for delivery to Los Angeles. It is expected that the flow through the tunnel will approximate 480 second-feet, or 215,424 gallons per minute.

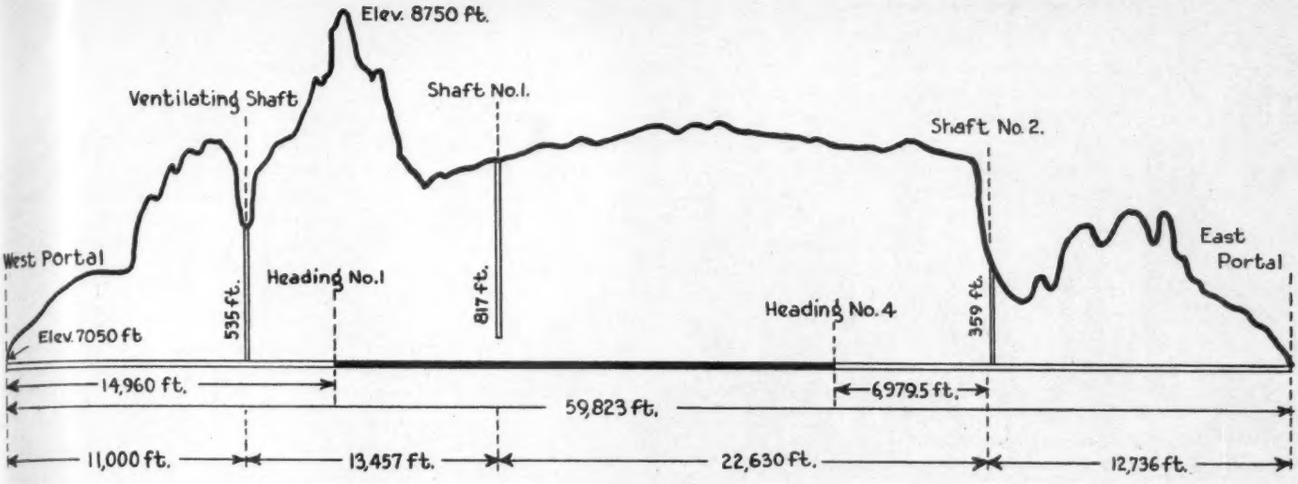
Of the 11.3 miles of tunnel to be bored through volcanic formations, ranging from the hardest rock to the loosest of running sand, more than one-half has now been driven. The tunnel will be horseshoe shaped, 9 feet high, 9 feet 7½ inches wide, and will be lined with concrete. Water has been encountered flowing at rates of from 150 to 5,000 gallons per minute, necessitating the installation of dewatering pumps and lines. Carbon-dioxide gas was met at a point about 11,000 feet in from the west portal, making it imperative to sink a perpendicular shaft, 535 feet deep, through which a blower system operates. Minor quantities of the gas are, it is found, taken up by the water and thus escape via the dewatering lines.

Initial work on the project was started in July, 1934, and involved the erection of dormitories, shops, storehouses, a hospital, school, etc. Each dormitory has eighteen rooms and each room is arranged to accommodate two men. The buildings are distinctly modern, each being provided with electric light, hot and cold water, gas heat, toilets, showers, a washroom, and an assembly room. The kitchens are electrically equipped throughout and present a sharp contrast to those of the old-time construction and mining camps. The field hospital at the West Portal Camp is complete in every respect with X-ray and treatment rooms and is supervised by two doctors assisted by an adequate staff of trained male nurses. Three motor ambulances are available and ready to move instantly in case of emergency. Also at the west portal is the public school for the children in the camp. The shops and storehouses are up to date and are fully capable of maintaining and repairing all the machinery, tools, and equipment on the job. Because of the severity of the winters in that region all the buildings have been substantially constructed and are kept in excellent condition.

Actual tunneling operations were begun at the west portal on September 25, 1934, and at the end of June 30, 1935, some 5,000 feet had been driven and the sides and roof for a distance of 1,878 feet had been timbered.

FRONT OF DRILL CARRIAGE

Drilling is done with four drifter drills at each heading. These are mounted, two to a deck, on a double-deck drill carriage that runs on rails. The average round consists of 32 holes each 11 feet deep, and the usual drilling time is about one hour.



PROFILE OF TUNNEL AND PROGRESS TO NOVEMBER 30, 1936.

Excavating at the east portal was taken in hand on November 23, 1934, and by June 30 of the following year the tunnel had been advanced 3,790 feet and timbered the entire way. The total footage at the expiration of the fiscal year amounted to 8,849 feet, or an average of approximately 32 feet per day.

A shaft, designated as No. 1, was started on November 28, 1934, at a point 24,457 feet east of the west portal. To reach tunnel grade, it had to have a depth of 955 feet; and by June 30, 1935, it had been sunk 539 feet and timbered. During the next year it was carried down an additional 224 feet, making a total of 763 feet and leaving 192 feet still to be completed.

The obstacles encountered in sinking this shaft have been of the most trying nature, consisting of shifting ground, loose, running sand, and great quantities of water under pressure. As a result, progress has been much impeded. Virtually no headway has been made in recent months; and at the beginning of the year there still remained around 150 feet to be excavated. The work of lining the finished section with reinforced concrete is nearly done, and it is expected that the sinking will proceed faster from now on.

Another shaft, known as No. 2, was opened on February 9, 1935. It is 359 feet deep and located 12,736 feet in from the east portal and 22,630 feet away from Shaft No. 1. By June 30, 1935, about 95 per cent of it had been lined. Both these shafts are approximately 20x6 feet in cross section, providing room for two skips, water discharge lines, air lines, electric cables, and a safety ladder.

Upon the completion of No. 2 Shaft, headings were advanced along the tunnel line in both directions, the westwardbound one being designated Heading No. 4 and the eastwardbound one No. 5. The number of points of attack was accordingly increased to four, and progress, in consequence, greatly accelerated. During the fiscal year ending June 30, 1936, a total of 21,841 feet of tunnel was excavated. Of this, 9,963.8 feet required the setting of timbers or some other form of support. The daily advance averaged 60 feet, as compared with 32 feet during the preceding year.

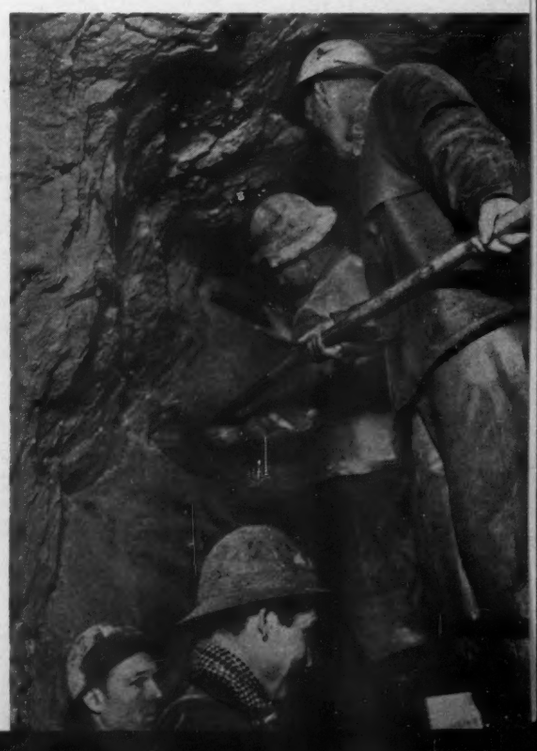
Crews at No. 6 Heading, being driven westward from the east portal, and at No. 5 Heading, going eastward from Shaft No. 2, met on July 7, 1936. Concreting of the invert has since been started at the east portal. From June 30 to November 30, 1936, the tunnel was advanced 3,944 feet, the work then being mainly confined to two headings. However, as soon as Shaft No. 1 is completed, Headings Nos. 2 and 3 will be carried westward and eastward, respectively, from that point: there will again be four headings to expedite tunneling, and progress will therefore be practically doubled. On November 30, last, there remained to be excavated 25,189 linear feet out of a total of 59,823 feet.

Drilling at each heading is being done with four drifters which are mounted two on each platform of a 2-deck drill carriage that runs on rails. Hollow, round steel of 1¼-inch section is used in lengths of from 4 to 32 feet, with 4-foot changes. The average round consists of 32 holes, 11 feet deep. The drilling time per round is normally one hour. Muck is loaded by a Conway loader into 4-ton, 70-cubic-yard dump cars that are hauled by a battery-type electric locomotive.

Compressed air is supplied to the drills by stationary, electric-driven compressors which are installed just inside the two portals and at the bottom of Shaft No. 2. The air is delivered to the working faces through 6-inch pipe lines and is maintained at 80 pounds pressure at the drills.

As the working area is located amid the high Sierra Nevada Mountains, the men on the project find excellent fishing, hunting and hiking. Winter brings with it a variety of outdoor sports, including skiing, ice skating, and snowshoeing, although the latter, in many cases, has become a necessity rather than a recreation. Altitudes approximating 7,000 feet and more assure clean, pure air and the healthiest of conditions for those acclimated.

The entire project, with the exception of small trucking contracts, is under the direct supervision of the Department of Water & Power, Bureau of Water Works & Supply, City of Los Angeles. H. A. Van Norman, chief engineer and general manager of water works, is in active charge, and is assisted by R. R. Proctor, engineer in charge of construction and design; S. M. Dunn, directing design, purchase, and installation of major mechanical equipment; Robert G. Martin, general foreman of tunnel driving; H. L. Jacques, engineer of major construction; J. P. Caulfield, directing the sinking of Shaft No. 1; and Stanley Dunham, directing concreting operations.



LOADING HOLES

Tamping sticks of dynamite into the breast preparatory to shooting a round. Note the rubber coats, hats, trousers, and boots which every man working in the tunnel must wear because of the wet conditions.

PROGRESS IN DRILLING

THE NEW Delaware Aqueduct of the New York City water-supply system, which is the subject of an article in this issue, will be bored entirely in rock, from 300 to 1,500 feet beneath the ground surface. It is significant to note that one of the reasons given by the engineers for electing this type of construction is the vast improvement in rock-tunneling equipment and methods that has been registered in recent years. In this connection it is interesting to observe that the entire span covering the development of the rock drill is encompassed within the nearly 100 years that New York has been creating its mountain water-supply system.

The first Croton works date from 1837 to 1842, before the birth of the mechanical drill. All excavating therefore had to be done with the aid of hand drilling. The New Croton Aqueduct was constructed from 1885 to 1890. Largely because of the availability of the piston drill it was built almost throughout its entire length of 33 miles in the form of a tunnel. Then came the Catskill Aqueduct, which coincided with a period of great rock-drill development. That was the era of enthusiasm for electric drills. Those machines were given a thorough trial, but they proved to be incapable of doing the work. Accordingly, the contractors installed compressor plants and began to employ cumbersome piston drills. In 1911, hammer-type drills and hollow drill steel were introduced. They had been used in the West for several years, but this was their first job in the East.

These first hammer drills averaged only about 2 inches of penetration per minute. That was an increase of approximately 25 per cent over the piston drills; and the new machines weighed only about one-third as much as their predecessors and were much easier to operate.

Just how far the rock drill had yet to go to reach its present stage of development can be made plain by pointing out that contractors on the new Delaware Aqueduct tunnel will have available for their use drifters that can drill at the rate of 20 inches per minute in hard granite. Truly, there has been an enormous increase in the efficiency of drilling equipment during the 26 years that have elapsed since hammer-type drills had their first test in the East.

MAKING JOBS SAFER

CONSTRUCTION work is inherently dangerous; but much is being done to make it safer. Today, one is probably less liable to be injured on any well-run construction undertaking than on the streets of a large city. Still there are inevitably accidents, chiefly because of the human factor and less because those in charge of large-scale projects fail to take all reasonable precautions to protect the workers.

Nineteen men lost their lives during the erection of the San Francisco-Oakland Bay Bridge. This is deplorable, and yet a review of the attending circumstances indicates that carelessness on the part of the men themselves was preponderantly to blame for those tragic deaths. In a letter published by the National Safety Council, Edgar N. Goldstine, consulting safety engineer on the bridge work, states that the men were not sacrificed to construction speed and that every request he made for minimizing hazards received reasonable response.

"I have felt from the beginning of the work," writes Mr. Goldstine, "that the key to accident prevention rested with the proper training of the entire organization. Some of the recommendations along these lines were not as fully accepted as they should have been, due partly to the failure of officials to realize the importance of such training." One contracting firm on the bridge that conducted such a course of training among its workers reduced the accident severity rate 50 per cent and the frequency rate 35 per cent. When the safety program was discontinued there was an immediate rise in both the severity and the frequency rates. Manifestly, it is not enough to provide physical safety devices: along with these there must be sustained education.

SPEED VERSUS POWER

DESPITE the assurance in a recent popular book that *Life Begins at Forty*, most persons who work for a livelihood become a little apprehensive about their future as they approach middle age. There is a distinct and deep-seated impression among workers that this is a young-people's world and that the "oldsters" must keep mentally "on their toes" if they are not to be outdistanced in the race of life.

The irresistible surge of confidence in youth is undeniably a great asset. Mistakes and setbacks do not weigh heavily on young shoulders, and young hearts are not easily depressed. But are young minds really more alert than more mature ones? Intelligence tests would seem to indicate that they are.

But there has now come forward a new school of psychologists that hastens to assure those of middle age that they are still very much to be desired as wage earners. It teaches that the human mind begins to lose some of its speed from the age of 27 onward, but that it loses none of its power. Apparently, the mind is like an automobile that has been driven a lot: it will no longer take the hills in high gear; but throw it into second and it reaches the top with plenty to spare.

The conclusions of the psychologists are backed by hundreds of tests. In virtually all cases, older persons took a little more time to answer questions than younger ones, but recorded just as high a percentage of correct replies. One of the leading exponents of this theory, Dr. Edward L. Thorndike of Columbia University, summarizes his findings as follows: "As far as mental ability is concerned, there need be no retiring age. The probabilities are that the older a person becomes, the more valuable he becomes. He possesses the same mental power he had in his young manhood plus his wealth of experience and knowledge of his particular job. These are things that no youngster, however brilliant, can pick up. For the same reason, there is a very definite value to the idea of 'elder statesmen' in politics and business."

This and That

Swiss Railway System

Because of the nature of the country which they traverse, Switzerland's railways are unusually expensive to build. An official statement gives the total cost of the Swiss Federal Railways as $641,000,000, of which $164,910,000 was spent for electrification. The over-all cost represents an average of $346,500 to the mile, and is very large in comparison with such expenditures in most countries. Swiss terrain calls for the building of high embankments, long tunnels, numerous bridges, and dams to protect the railroads against snowslides and avalanches. Of every 100 miles of railway, approximately 9 miles is in tunnel. Another factor in increasing the construction costs is the closeness of stations, the average distance between which is but 2.3 miles. The number of highway crossings likewise adds to the expense. All told there are 6,700 crossings. At 4,100 of these the highway and the railroad have the same grade, while grade separation is provided at the other 2,600.

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Bird Named Mine

It is an interesting research to trace the origins of the names of mines. Many of them have unusual ones, and in some cases they are even bizarre. The source of some of them has been lost. This seems to us to be unfortunate, for in most instances the discoverer was impelled by a strong motive to choose the particular appellation. Very often the name is closely associated with the man or men responsible for the mine, and the reason for its selection gives an insight into the characters involved.

Within the past two years a national magazine published a series of articles concerning Tom Walsh, discoverer of the famous Camp Bird Mine near Ouray, Colo. They were penned by his daughter, Evalyn Walsh McLean, Washington society woman, with the assistance of a professional writer. In all the thousands of words set down on paper there was no explanation of the genesis of the picturesque name of the mine that Walsh sold to an English syndicate for $10,000,000. This missing fact is now supplied, however, by Theol Merrie Bruin of Fort Worth, Texas, in a letter to the *Denver News*. Mr. Bruin lived in Ouray at the time Walsh, then well along in middle age, made the strike that elevated him to the Croesus of the Rockies.

It was Walsh's habit to roam the hills with only a gray burro for company. The burro carried grub, blankets, a pick, a shovel, and drill steel. On his own back Walsh toted a few sticks of dynamite. One day they passed near the abandoned shaft of the old Vigmas Mine in the Mt. Sneffels country. To the burro Walsh said: "We'll just take a peep at this old hole while we're up here." He prepared to eat his lunch, then curiosity urged him to descend the shaft, so he left the lunch on a nearby rock and climbed down the rickety ladder. He became absorbed in the rocks at the bottom of the opening, and it was several hours later that he reappeared aboveground. During his absence a flock of camp robber birds, with unerring instinct, had located his lunch. Only a few crumbs remained, and one stalwart bird was busily engaged in consuming those. "Ye damned auld fowl," ejaculated Walsh, as he shied a rock at the bird. And then, in reflection: "Ye may be a good omen at that."

Being superstitious, Walsh filed on the claim at once and christened it the "Old Camp Bird Mine." To his intimates he confided: "That auld bird was lookin' for something he needed when he gobbled up my lunch. Now I'm needin' something and I'm goin' to get it even if hell freezes over!"

After working the prospect for a number of months with the help of William Beaton, to whom he later gave $10,000, Walsh uncovered the vein that for him spelled the end of searching the hills. In after years, the word "Old" was dropped from the name, and the mine has since been known merely as the Camp Bird.

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Canada's Rare Metals

Along with her rapidly growing output of gold, silver, nickel, copper, zinc, lead, and other well-known minerals, Canada is becoming an outstanding producer of certain of the rarer metallic elements. For some years considerable quantities of platinum have been mined, and now cadmium, selenium, tellurium, and titanium are attaining commercial importance. In 1935, the Canadian Pacific Railway Company reports, the latter had an aggregate value of nearly $1,200,000, and it is believed that the 1936 figures will be appreciably larger. Cadmium has previously come almost entirely from zinc-bearing ores treated at Trail, B. C., by the Consolidated Mining & Smelting Company; but in 1936 the Hudson Bay Mining & Smelting Company began to obtain it from mill residues that had been accumulating since 1930 at its Flin Flon property. It is used chiefly as a substitute for tin in bearing metals, and as a pigment. Incidentally, Jackbits are plated with it. Selenium is produced as a by-product of copper ores by two Canadian refining companies and serves as a coloring and reducing agent in pottery and glass industries. It imparts a ruby tint to glass. It is also employed in the manufacture of cutting-tool steels and in vulcanizing rubber. Recently, large quantities of it have gone into the making of "electric eyes." Tellurium, which likewise comes principally from copper ores, is used in radio mechanisms, in photography, as an antiknock compound in gasoline, and as an alloy to give greater strength and toughness to lead. Titanium is derived from the ore ilmenite, which is found in several Canadian areas. It is employed as a pigment and is becoming important as an alloying agent.

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Champion Dam Builder

We have made previous reference in these pages to the growing list of dams that will stand as memorials to the construction genius of Ross White, general superintendent of construction for the TVA. When Mr. White went to the Tennessee Valley, he already had to his credit eight dams, located in the western part of this country and in Canada. After starting Norris Dam, in the TVA chain, he was elevated to his present post and has since had supervision of the five additional dams that are either built or are underway. Four more TVA dams are on the drawing boards and, if nothing intervenes, Mr. White will supervise their construction. In order that the rest of the country may share Mr. White's talents, the TVA has given him permission to engage in consulting engineering work, and he has already been retained as consultant on the Marshall Ford Dam, one of the three structures that will be erected on the Colorado River in Texas.

Incidentally, one of Mr. White's lieutenants in the TVA, E. M. Whipple, has been engaged by the McKenzie Construction Company, contractors for the Marshall Ford Dam, to superintend the latter work. Mr. Whipple served as assistant construction superintendent at Norris and Pickwick dams and has lately been superintendent at Chickamauga Dam. His place at Chickamauga will be filled by F. C. Schlemmer, who took over the construction of Norris Dam when Mr. White was promoted and who was afterward named construction superintendent of Hiwassee Dam.

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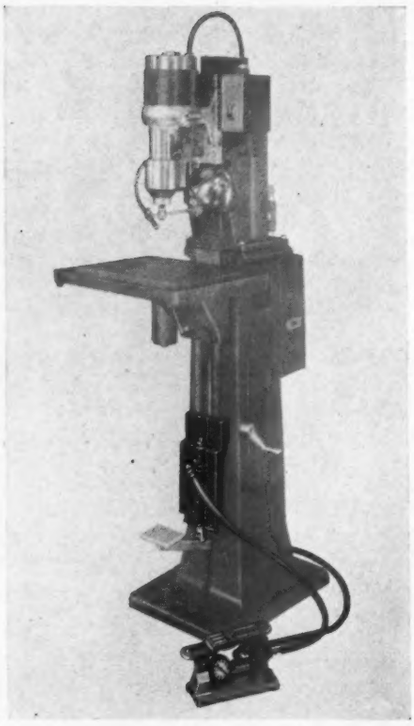
The Nth Degree of Loyalty

A large equipment manufacturer had occasion to install some of his own coke-burning equipment in connection with a certain firing process. After half-a-year's operation, the company officials were gratified to learn that coke-consumption figures, based on the fireman's records, almost tallied with the advertised fuel consumption for the equipment.

The accountants, however, were bothered by a discrepancy in inventory. Well over a carload of coke had vanished into clear sky. Their checking led to questioning the fireman about his records. Pressed, he finally admitted: "That burner, she have to be hot, so I put on more coke. No mark it down. Our book say she use so much. I no make book lie!"

SEPARATE AIR-CONTROL MECHANISM FOR TAPPING MACHINE



TO INCREASE the efficiency of its high-speed, precision tapping machines, the R. G. Haskins Company has developed what is known as Haskins Air Control, a separate attachment with which either new or old tappers can be equipped without the need of alterations. It consists of an air cylinder, of a foot-operated valve that is provided with a gauge and regulator, and of suitable hose connections. The pneumatic cylinder, as the accompanying illustration shows, is mounted on the column of the machine immediately above a pedal by means of which the tapping operation is controlled—the machine itself being run by an electric motor.

Heretofore the amount of pressure applied to the pedal depended entirely upon the operator, and was therefore variable. Now the valve is set to meet the requirements of the job in hand and each time it is actuated, air at uniform pressure is admitted to the cylinder, thus forcing down the plunger to which the pedal is attached. According to the manufacturer, the new device not only controls the speed of feeding and of reversing the tap but also maintains the pressure throughout the length of the stroke, incidentally relieving the operator of the fatiguing work of gauging the pressure.

COMBINATION STRAIGHTENER AND SHEARER

BOLTS, nails, rods, bars, and pieces of wire that have seen service and are still good except for minor faults can be prevented from reaching the scrap pile by reconditioning them on an improved type of straightener and shearer lately announced by The American Foundry Equipment Company. The machine comes in various sizes from a unit standing 30 inches high and capable of taking up to ¼-inch stock to one measuring approximately 29x42x76 inches and designed to handle material not exceeding 2½ inches. All but the first named are operated with compressed air—60 pounds pressure per square inch being the minimum required for satisfactory service.

With the exception of the cylinder parts, which are of cast iron, the machine is of rugged cast-steel construction. The straightening mechanism consists of dies, made of manganese steel, which close on a bar or rod as a contracting square and deliver an impact on the four sides simultaneously. The force of the blow is controlled by a hand lever, which actuates an air throttle valve. The shear jaws, on the left-hand side of the unit shown, come together on each down stroke of the cylinder. They carry removable blades of hardened steel which can be successively turned so as to present all four edges before requiring replacement. It is said that the rapidity with which both straightening and shearing can be done is limited only by the speed with which the machine can be fed.

Courtesy, Steel

DESCALING WITH GAS AND AIR

Here we see an innovation in descaling apparatus built by the C. M. Kemp Manufacturing Company to supplant acid pickling. It is simply a gas burner consisting of a hollow steel casting, 10 inches long and 4½ inches wide, and of a handle made of a piece of gas pipe that is set at an angle to facilitate moving the descaler back and forth over a bloom or billet. The gas is fed through a flexible rubber hose connection and issues from twelve alloy-steel tips screwed into the bottom of the casting. Each of these tips is ¾ inch in diameter and pierced with a number of holes to spread the flame. The fuel is an admixture of gas and air to assure complete combustion and is supplied at a pressure of 2.5 pounds. As the operator pushes the burner face down over a bloom or slab the heat raises the scale, which is then blown off with compressed air, leaving a clean surface. The pictures show the descaler in use in the plant of Spang-Chalfant & Company, Inc.

Industrial Notes

Have you ever talked from New York to Los Angeles? If so, your words have traveled over 3,000,000 pounds of copper wire.

Statistics reveal that the people of the United States are great travelers. In 1936, motor cars, buses, and railroads had a record of 236,000,000,000 passenger miles, or approximately 1,840 miles per capita.

In Japan, where salt is obtained exclusively from sea water, a professor of the Tokyo Imperial University has succeeded in extracting commercial potassium sulphate from the residual brines by treating them with aluminum sulphate, which is subsequently recovered. It is said that the available brines could be made to yield about 20,000 tons by this patented process.

For glazing, pointing, calking, etc., the Plastic Products Company is offering a new sealing compound called Plastoid Aluminum Plastic. It is an aluminum powder in a plastic vehicle, and is made in consistencies varying from a thin mixture for application with a brush to a putty that can be handled with a knife. The material is said to be proof against water, weather, and vibration; and with the exception of the outer metallic film remains plastic when set.

The electrometallurgical laboratory of the U. S. Bureau of Mines, in its first report, announces the development of a simple and cheap process of extracting metallic manganese from its ores. The work is done by leaching and electrolysis. The necessary manganese-sulphite electrolyte is made easily, it is said, and the power required per ton of metal will not exceed 4,000 kw-hrs. "Utilizing large low-grade deposits located close to Boulder Dam and other Federal power projects, the power cost for high-purity manganese metal may be only $10 a ton."

At the quarry of the American Limestone Company, Knoxville, Tenn., a guard rail is made to do triple duty. It runs along the steps and walkway of the belt conveyor extending from the crusher to the top of the screening plant and is fashioned of 1-inch steel piping. Whenever a motor is to be cleaned or a drill operated, air at 90 pounds pressure is turned into the line, which is connected with the compressor plant by a 1-inch underground pipe and is provided with a valve at each end. In case of fire it can be hooked up with the plant water-supply system and thus made to serve as an emergency water main.

For thawing frozen grease in transmissions, axle housings, etc., J. B. Timberlake & Sons is offering a hot-air gun. The Thaw-it Gun, as it has been named, is designed to be fastened to an air line and is provided with an 825-watt electric element that heats the compressed air as it passes through the 3-inch-diameter barrel. It has an over-all length of 16 inches, including the nozzle, which can be inserted in a 9/16-inch opening and has a removable tip with a cone-shaped collar. The latter serves to seal the entrance to a crankcase so as to confine the air. A knurled nut at the rear of the gun controls the air supply.

It sounds paradoxical, but soap is being produced from coal. That is, paraffin obtained in the distillation of brown-coal tar is being made to yield a white fatty acid that lends itself to saponification. The process by which this is effected is a new one, and reduces the paraffin to a molten state in which it is subjected to the oxidizing action of air which is blown through it for a prolonged period and supplemented by a suitable catalyzer. In Germany, where there are unlimited resources of brown coal, the invention is looked upon as an important one because of the present shortage of fats.

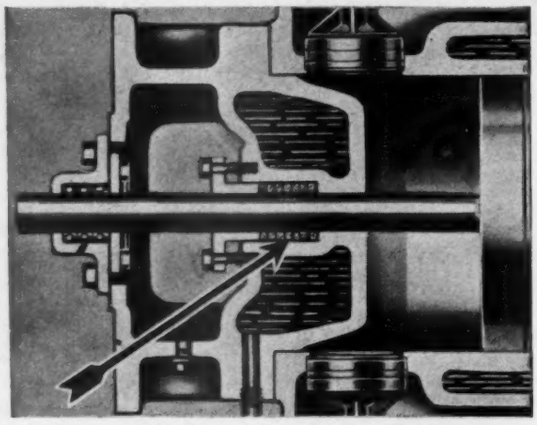
Although designed for peacetime service, an electric power shovel built by the Harnischfeger Corporation for the Chile Exploration Company has all the appearance of a war machine. The operator's cab is of armor plate, and all exposed parts are protected so that the shovel can stand its ground every time a blast is fired. Blasting occurs frequently in the open-pit copper mine where it works; and it was to save the time ordinarily required to move so large a piece of equipment out of harm's way that the side and rear walls and the top of the cab were constructed of armor plate ½ and ⅜ inch thick, respectively. Instead of retreating before each shot, the sturdy shovel simply turns its back until the hail of stones is over.

Glaring lights that are a source of discomfort and even danger to motorists can be offset by the wearing of a new kind of glasses that has been put on the market by the Willson Products, Inc. Each lens is made up of two pieces of glass of which the lower and larger one, for general vision, is tinted slightly and the upper one is dark for night driving. By slightly inclining his head, the wearer can look right at brilliant lights that would otherwise momentarily blind him. The glasses come in clip-on and spectacle style, and are sold under the trade name of Da-N-Nite.

Copper sheeting of exceptional thinness is being made by a new method of electrodeposition developed by V. L. Tannehill of Process Molds, Inc., Fort Wayne, Ind. The metal is deposited on special belts of nickel-chromium alloy which travel continuously through an acid-plating solution that is also new. The sheets so produced are stripped from the belts and are said to be smooth and dense and to compare favorably with the rolled stock. They can be used variously in the electrical industry, for roofing, for the making of decorative panels, gaskets, and many other things. In the case of gaskets, for example, they are produced with the different holes in them by means of forms on which the copper is deposited only where desired. Sheets 0.001 inch thick and 20 inches wide have been satisfactorily made, the width being limited only by the width of the belt.

Passing Show

"Would you mind movin' your car, Guv'nor?"



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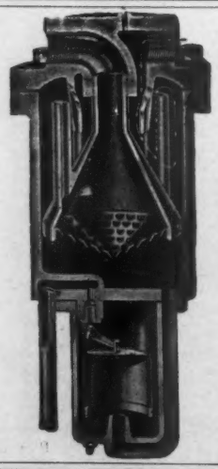

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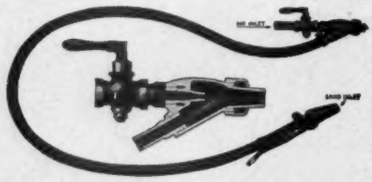

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